NAVAIR 16-30URM52-2
(USAF) T.O. 33A1-8-20-2

Manual

Service Instructions

SIGNAL GENERATOR

AN/URM-52
AN/URM-52A
AN/URM-52B

PUBLISHED UNDER AUTHORITY OF THE SECRETARY OF THE AIR FORCE
AND BY THE DIRECTION OF THE COMMANDER OF
THE NAVAL AIR SYSTEMS COMMAND

15 May 1953
Revised -1 October 1967

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Page No.	Date of Latest Revision	Page No.	Date of Latest Revision
* i	1 October 1967	37	15 December 1957
iii	15 December 1957	39 thru 43	15 December 1957
* 1	1 October 1967	44 thru 48	1 June 1957
2	15 December 1957	49	15 June 1963
* 3	1 October 1967	50	1 June 1957
4	15 December 1957	51	1 June 1957
4A	15 December 1957	52A	15 December 1957
5	15 December 1957	53 thru 55	15 June 1963
9	15 December 1957	56	15 December 1957
10	1 June 1957	56A	15 December 1957
11	15 December 1957	57 thru 59	15 December 1957
12	1 June 1957	63	15 December 1957
13	15 December 1957	64	15 December 1957
14	1 June 1957	64A thru 64D	15 December 1957
22	15 December 1957	65 (Deleted)	
25	15 June 1963	68	15 December 1957
26	15 December 1957	68A	15 June 1963
26A	15 December 1957	68B	15 June 1963
29	15 June 1963	69	1 February 1960
30	1 June 1957	69A (Deleted)	
31	1 June 1957	70 thru 80	15 June 1963
33 thru 36	15 December 1957	* 81 thru 87	1 October 1967
36A	15 December 1957	* 89 thru 97	1 October 1967

* The asterisk indicates pages revised, added or deleted by the current revision

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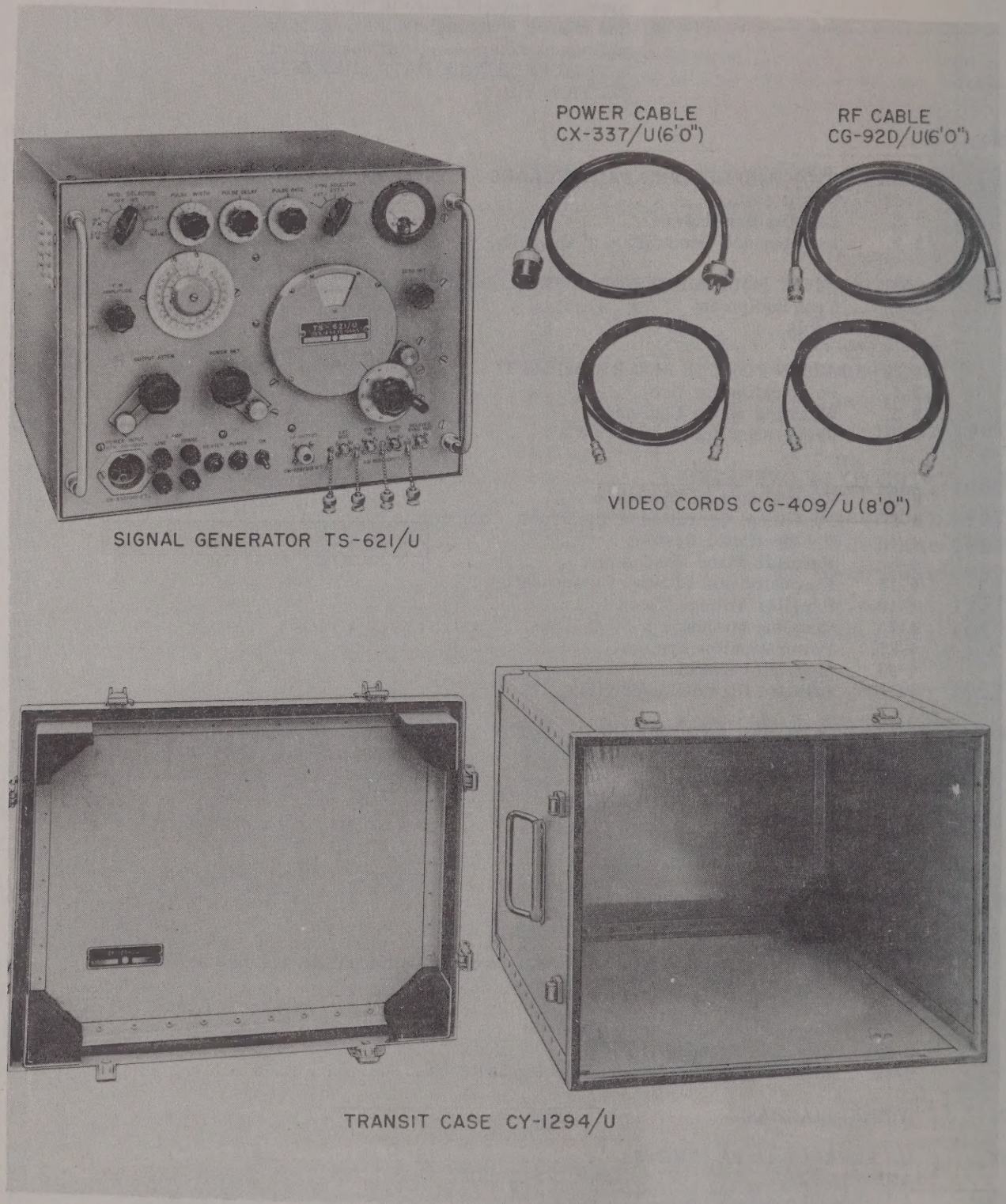


Figure 1-1. Signal Generator AN/URM-52, Equipment Supplied

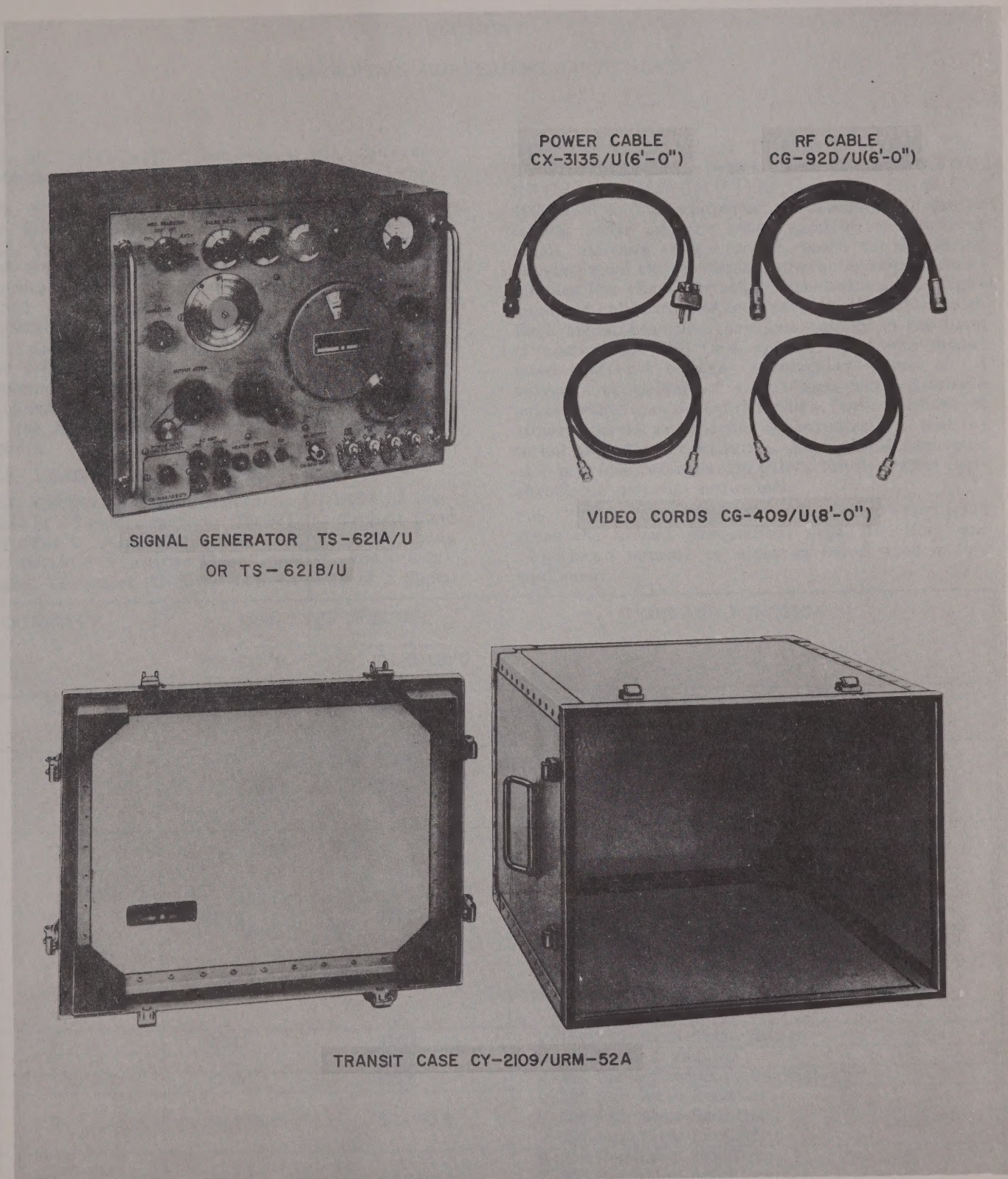


Figure 1-1A. Signal Generator AN/URM-52A, Equipment Supplied

SECTION I

DESCRIPTION AND LEADING PARTICULARS

1-1. IDENTIFICATION. See Section VIII, Difference Data Sheets, for Model Differences.

1-2. This publication contains service instructions for Signal Generators AN/URM-52 and AN/URM-52A. The equipment is used for testing, calibrating and aligning various types of electronic equipment operating within the frequency range of 3,800 to 7,500 megacycles per second. Signal Generators AN/URM-52 and AN/URM-52A are functionally identical and may be used interchangeably. Mechanically and electrically there are minor differences. The equipment is manufactured in accordance with Specification MIL-G-7141(Aer), dated 15 February 1951 by the Hewlett-Packard Company, Palo Alto, California.

1-3. LEADING PARTICULARS.

1-4. GENERAL. Signal Generator AN/URM-52 consists of a Signal Generator TS-621/U, Transit Case CY-1294/U, Power Cable CX-337/U(6'0"), RF Cable CG-92D/U(6'0") and two Video Cords CG-409/U(8'0"). Signal Generator AN/URM-52A consists of a Signal Generator TS-621A/U or TS-621B/U, Transit Case CY-2109/URM-52A, Power Cable CX-3155/U(6'0"), RF Cable CG-92D/U(6'0") and two Video Cords CG-409/U(8'0"). The equipment is designed for use in testing radar and for other applications requiring small amounts of r-f power, such as measuring standing wave ratios, antenna characteristics, transmission line characteristics, conversion gain, alignment and calibration of receivers, and similar uses. Each signal generator provides outputs in the form of continuous (CW), r-f voltage, frequency modulated (FM) r-f voltage, rectangular pulses of r-f voltage, or pulses of r-f voltage with adjustable pulse width and repetition rates, with a choice of either internal or external synchronization, and internal or external modulation. Each signal generator also provides two separate pulses for use when synchronizing external equipment.

1-5. TUBE COMPLEMENT. The following table gives the circuit designation, type, function, and required number of electron tubes used in this equipment:

QUANTITY	JAN TYPE NUMBER		TUBE AND FUNCTION
	TS-621/U TS-621A/U	TS-621B/U	
2	12AT7	12AT7WA	V-101 SYNC. IN Amplifier and Inverter V-112 Clipper and Klystron Grid Clamp
3	5726	5726	V-102 Coupling Diode (1/2 tube not used) V-106 Base Limiter and Clamp for Delay Multivibrator V-108 Clamp and Negative Pulse Clipper
7	5814	5814	V-103 PULSE RATE Multivibrator V-104 SYNC. OUT Pulse Shaping Multivibrator V-105 Pulse Amplifier and SYNC. OUT Cathode Follower V-107 PULSE DELAY Multivibrator V-109 Pulse Amplifier - Inverter and DELAYED SYNC. OUT Cathode Follower V-111 PULSE WIDTH Multivibrator V-115 DELAYED SYNC. OUT Pulse Shaping Multivibrator
1	2D21	2D21	V-110 Thyratron Pulse Shaper
1	5763	5763	V-113 Pulse Modulator
1	6236	6236	V-114 Radio Frequency Oscillator
3	5R4WGY	5R4WGB	V-301 Full Wave Rectifier V-305 Full Wave Rectifier V-307 Full Wave Rectifier
3	6AU6	6AU6WA	V-302 Regulator Amplifier V-306 Regulator Amplifier V-309 Regulator Amplifier
2	6A57	6080WA	V-303 Series Regulator V-308 Series Regulator

QUANTITY	JAN TYPE NUMBER		TUBE AND FUNCTION
	TS-621/U TS-621A/U	TS-621B/U	
5	OA2	OA2WA	V-304 Voltage Regulator V-310 Voltage Regulator V-311 Voltage Regulator V-313 Voltage Regulator V-314 Voltage Regulator
1	OA3	OA3	V-312 Voltage Regulator

1-6. FUSE COMPLEMENT. The equipment uses the following fuses: Number of fuses - 2, rated at 3.2 amperes each (slow-blow).

1-7. FREQUENCY RANGE AND OUTPUT CHARACTERISTICS. Frequency Range - 3,800 to 7,500 megacycles per second. R-F output - rated at -10 to -127 db, referenced to 1 milliwatt, into 52 ohm load.(0.072 volt to 0.1 microvolt). Equipment is capable of providing maximum power of 1 milliwatt.

Type of R-F Output	Type of Sync or Mod	Input Signal Voltage Range	Repetition Rate of Sync or Mod	Range of Pulse Duration
Continuous Wave (CW)	- - -	- - -	- - -	- - -
Square Wave	Internal	- - -	40 to 4,000 pps	- - -
Pulsed	Internal	- - -	40 to 4,000 pps	0.5 to 10.0 microseconds
	External Sync	5 to 50 volts SYNC. IN signal	40 to 4,000 pps	0.5 to 10.0 microseconds
	External Modulation + or -	15 to 70 volts EXT. MOD. signal	Pulse Separation 1.0 to 2500 microseconds	0.5 to 2500 microseconds
Frequency Modulation (FM)	Internal Modulation	- - -	FM rate 40 to 4,000 cps	- - -
	External Modulation	R-F OUTPUT Frequency: Below 4000 mc — Maximum peak to peak EXT. MOD. Voltage: 25 volts; 4000 to 5000 mc: 50 volts; Above 5000 mc: 100 volts	40 to 4,000 cps	- - -

Also available from separate panel connectors are two synchronizing pulses described below:

(a) Essentially at Start of Sync - +25 volts, duration approximately 2 microseconds, into load of 1,000 ohms to 100K, with shunt capacitance of not more than 500 micromicrofarads.

(b) At Start of R-F Pulse - +25 volts, duration approximately 2 microseconds, into load of 1,000 ohms to 100K, with shunt capacitance of not more than 500 micromicrofarads.

1-8. POWER INPUT. Voltage input - 115 ± 10% volts, single phase, 50 to 1000 cycles, current - 2.1 amperes. (See Section VIII for other model equipments).

1-9. LOCATION AND FUNCTION OF OPERATING CONTROLS AND ADJUSTMENTS. The operating controls of the signal generator are illustrated in figures 1-2 and 1-2A. In each of the following descriptions, the number in parentheses after the name of the control corresponds to the number of the callout of the control in figures 1-2 and 1-2A. Switch positions are not referenced by number. All the controls are located on the front panel. A description of their functions follows:

a. ON switch (1). When this switch is in the up, or ON, position, power is applied to the electronic circuits of the signal generator. When it is in the downward position, power is applied to the space heaters in the cabinet that are employed to dehumidify the interior of the signal generator when the signal generator is not in use.

b. POWER indicator (2). When this indicator is on, HEATER indicator (3) will be off. This indicates that power is applied to the electronic circuits of the signal generator, and removed from the space heaters.

c. HEATER indicator (3). When this indicator is on, POWER indicator (2) will be off. This indicates that power is applied to the space heaters and removed from the electronic circuits.

d. SIGNAL FREQUENCY control (4). This control is used to adjust the klystron oscillator to the desired frequency. This frequency is indicated on the MEGACYCLES dial (5) above the control. A continuously rotatable vernier scale graduated from zero to 100 is provided on the control itself so that accurate resetting to a specific frequency can be made.

e. ZERO SET control (6). This control is used to adjust the needle of the POWER SET meter (8) to the zero position when the MOD. SELECTOR switch (upper left-hand corner of the panel) is in the OFF position.

f. POWER SET control (7). This control is used to adjust the needle of the POWER SET meter (8) to 0 DBM (red line at center of scale) prior to adjusting the attenuation. It also operates the transparent index window (9) over the OUTPUT ATTEN. (attenuator) dial to establish the reference level for reading the attenuator dial.

g. OUTPUT ATTEN. (attenuator) control (10). This control determines the radio frequency output level of the signal generator. It also operates the OUTPUT ATTEN. dial (11) so that the reading of this dial under the index line (a) indicates the output level of the signal generator in terms of decibels below one milliwatt.

h. FM AMPLITUDE control (12). This control adjusts the deviation (frequency swing) of the output frequency from the center (CW) frequency when frequency modulation is employed. Because of the characteristics of the klystron, the frequency deviation should be held to a value below that which would result in instability. If unstable operation should occur, the FM AMPLITUDE control should be returned to the OFF (counter-clockwise) position and then slowly rotated clockwise to a position just short of where instability occurred.

i. MOD. SELECTOR switch (13). This switch is located in the upper left-hand corner of the front panel of the signal generator. It has the following positions:

1. EXT. FM. When the switch is in this position, the signal generator circuits are connected so that an external sine or saw-tooth voltage may be applied to the EXT. MOD. connector (20) to provide frequency modulated output. Refer to paragraph 1-7 for limits of voltage which may be used.

2. INT. FM. When the switch is in this position, the signal generator circuits are connected so that frequency modulated r-f voltage is provided at the output. When the SYNC. SELECTOR switch (17) is in the X1 or X10 position, these pulses are initiated by the pulse generating circuits of the signal generator, and the recurrence rate of frequency deviation is determined by this setting of the PULSE RATE control, and by the SYNC SELECTOR switch (X1) of X10 position. At the start of each recurring frequency variation, a synchronizing pulse is provided at SYNC. OUT connector (22).

3. CW. When the switch is in this position, the output from the signal generator is a continuous wave of r-f voltage.

4. OFF. When the switch is in the OFF position, the r-f oscillator tube is biased off so that the signal generator will provide no output. This position is provided to permit the POWER SET meter (8) to be zero set before each test by adjustment of the ZERO SET control (see paragraph 3-5). However, filament and plate voltages remain applied to all tubes so that the signal generator may be instantly operative when MOD. SELECTOR switch is moved to one of its other positions.

5. INT. When the switch is in this position, the pulse repetition frequency is indicated by the position of the PULSE RATE control (16) when the SYNC. SELECTOR switch (17) is in the X1 position. When the latter control is in the X10 position, the pulse rate will be 10 times the rate indicated by the PULSE RATE control (16). When the MOD. SELECTOR switch (13) is in the INT. position and the SYNC. SELECTOR switch (17) is in one of the three most counter-clockwise positions, the internal pulse generating circuits are synchronized by an external source of voltage. Refer to item m below for a complete description of operation of the SYNC. SELECTOR switch (17).

6. EXT. +. When the switch is in this position, the signal generator may be modulated by positive pulses of voltage applied externally to the EXT. MOD. connector (20) on the front panel.

7. EXT. -. When the switch is in this position, the signal generator may be modulated by negative pulses of voltage applied to the EXT. MOD. connector (20) on the front panel. Refer to paragraph 1-7 for permissible range of characteristics of both positive and negative

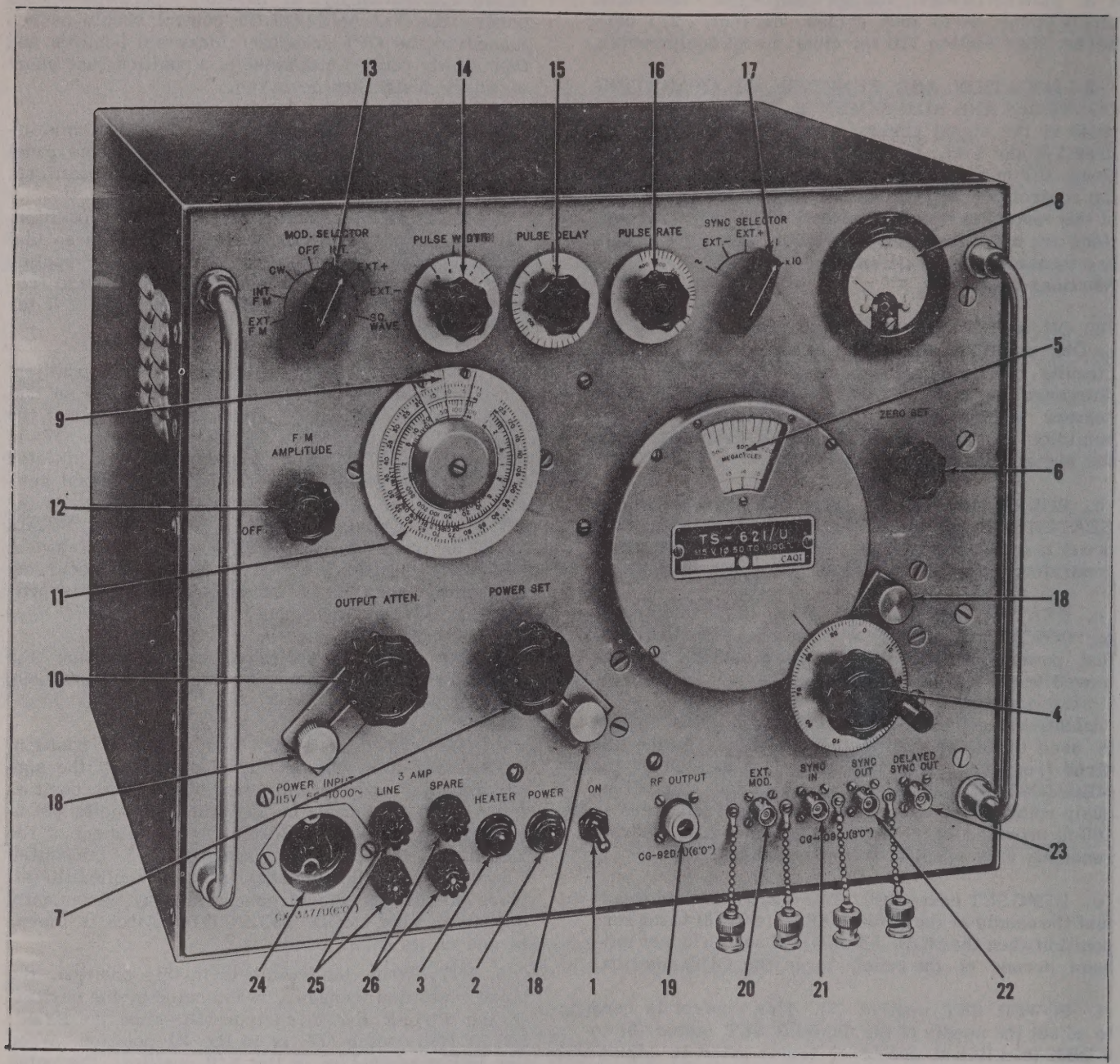


Figure 1-2. Signal Generator AN/URM-52, Operating Controls and Connectors

1. ON switch
2. POWER indicator
3. HEATER indicator
4. SIGNAL FREQUENCY control
5. MEGACYCLES dial
6. ZERO SET control
7. POWER SET control
8. POWER SET meter
9. Attenuator dial index
10. OUTPUT ATTEN. control
11. OUTPUT ATTEN. dial
12. FM AMPLITUDE control
13. MOD. SELECTOR switch
14. PULSE WIDTH control
15. PULSE DELAY control
16. PULSE RATE control
17. SYNC. SELECTOR switch
18. Control locks
19. RF OUTPUT connector
20. EXT. MOD. connector
21. SYNC. IN connector
22. SYNC. OUT connector
23. DELAYED SYNC. OUT connector
24. POWER INPUT connector
25. Line fuseholders
26. Spare fuseholders

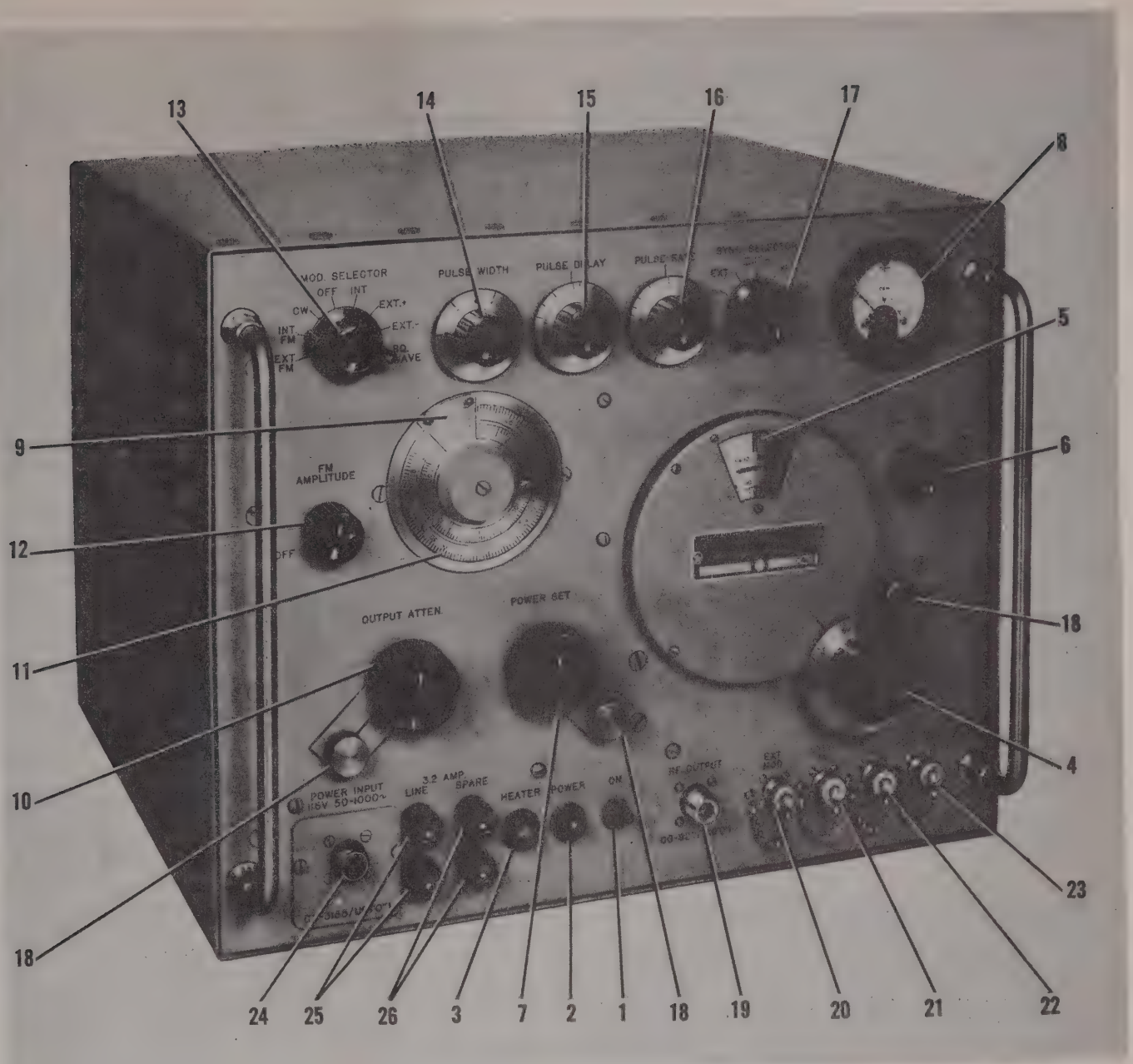


Figure 1-2A. Signal Generator AN/URM-52A, Operating Controls and Connectors

1. ON switch
2. POWER indicator
3. HEATER indicator
4. SIGNAL FREQUENCY control
5. MEGACYCLES dial
6. ZERO SET control
7. POWER SET control
8. POWER SET meter
9. Attenuator dial index
10. OUTPUT ATTEN. control
11. OUTPUT ATTEN. dial
12. FM AMPLITUDE control
13. MOD. SELECTOR switch
14. PULSE WIDTH control
15. PULSE DELAY control
16. PULSE RATE control
17. SYNC. SELECTOR switch
18. Control locks
19. RF OUTPUT connector
20. EXT. MOD. connector
21. SYNC. IN connector
22. SYNC. OUT connector
23. DELAYED SYNC. OUT connector
24. POWER INPUT connector
25. Line fuseholders
26. Spare fuseholders

pulses employed for externally modulating the r-f output of the signal generator.

8. SQ. WAVE. When the switch is in this position, the signal generator provides rectangular pulses of radio frequency voltage. The repetition rate of these pulses is determined by the setting of the PULSE RATE control, and by the SYNC. SELECTOR switch (X1 or X10 position) over the range of 40 to 4,000 pulses per second. The "on" time is approximately equal to the "off" time at 1,000 pps. As the repetition rate is increased or decreased from 1,000 pps the duty cycle will vary considerably. At the start of each cycle of rectangular pulse a synchronizing pulse is provided at the SYNC. OUT connector (22).

j. PULSE WIDTH control (14). The adjustment of the calibrated control determines the time duration of the pulse of radio frequency voltage when the MOD. SELECTOR switch (13) is in the INT. position. The time duration is adjustable from 0.5 to 10 microseconds.

k. PULSE DELAY control (15). This control determines the time delay between the start of the synchronizing pulse and the start of the radio frequency output pulse delivered by the signal generator, regardless of the type of synchronization employed. The control permits the insertion of delays from 3 to 300 microseconds following the synchronizing pulse. The same delay will be present between the pulses appearing at the SYNC. OUT connector (22) and the delayed SYNC. OUT connector on the control panel. The output from either connector may be employed for synchronizing external equipment.

l. PULSE RATE control (16). The setting of this control determines the pulse repetition frequency generating circuits when the MOD. SELECTOR switch (13) is in the INT., INT. FM, or SQ. WAVE position, and the SYNC. SELECTOR switch (17) is in either the X1 or the X10 position. When the SYNC. SELECTOR switch is in the X1 position, the pulse repetition rate is indicated directly on the calibrated dial of the control. When the SYNC. SELECTOR switch is in the X10 position, the pulse repetition rate is 10 times the value indicated on the PULSE RATE control.

m. SYNC. SELECTOR switch (17). This switch determines the type of synchronization that is to be employed by the signal generator. It has the following positions:

1. When the switch is in this position and the MOD. SELECTOR switch (13) is in the INT. position, the signal generator may be synchronized by sine wave voltages with an amplitude between 5 and 50 volts rms, applied through the SYNC. IN connector (21) on the front panel.

2. EXT. -. When the switch is in this position, the signal generator may be synchronized by negative voltage pulses with an amplitude between 5 and 50 volts peak, applied through the SYNC. IN connector (21) on the front panel.

3. EXT. +. When the switch is in this position and the MOD. SELECTOR switch (13) is in the INT. position, the signal generator may be synchronized by positive voltage pulses with an amplitude between 5 and 50 volts, applied through the SYNC. IN connector (21) on the front panel.

4. X1. When the switch is in this position and the MOD. SELECTOR switch (13) is in the INT. position, synchronization is by the internal time base circuit. The repetition rate of the r-f output pulses is read directly on the PULSE RATE control (16).

5. X10. When the switch is in this position and the MOD. SELECTOR switch (13) is in the INT. position, the repetition rate of the r-f output pulses is 10 times the rate indicated by the PULSE RATE control (16).

NOTE

Throughout this handbook, reference to the signal generator will include Signal Generators TS-621/U, TS-621A/U and TS-621B/U unless otherwise indicated.

1-10. Sections I through VII of this handbook apply to Signal Generators AN/URM-52 and AN/URM-52A. Additional models will be covered in Section VIII by the use of Difference Data Sheets. Service instructions for models included in Section VIII are the same as the procedures given in Sections I through VII, except for the specific differences noted by the applicable Difference Data Sheets.

SECTION II

SPECIAL TEST EQUIPMENT AND SPECIAL TOOLS

2-1. TEST EQUIPMENT.

2-2. No special test equipment has been procured for maintenance. However, the test equipment listed in the following table is required to perform the various tests and adjustments indicated in Section V and Section VI.

TEST EQUIPMENT REQUIRED FOR MAINTENANCE

FIGURE AND INDEX NO.	NAME	AN TYPE OR CHARACTERISTIC	ALTERNATE	APPLICATION
Throughout Sections V and VI	Oscilloscope	AN/USM-24	TS-239/UP LA 239	Waveform Observation
Figure 6-2	Audio Oscillator	TS-382A/C	Hewlett-Packard 200C	Used to check sync/action, and to measure pulse rate.
Figure 6-3	Crystal Detector	Freq. Range: 2.5 to 12.5 kmc Tuning: Single Stub Connectors UG-21B/U (RF input); BNC jack (Detector output)		Used as demodulator in conjunction with oscilloscope.
Figure 6-1	Pulse Generator	SG-30/UP	Meas. Corp. Mod 79. Hewlett-Packard 212A	Used to trigger pulse circuits of signal generator, and to check the accuracy of the pulse.
Figure 6-11	Microwave power meter	Full scale readings of .1, .3, 1, 3 & 10 mw. Continuous readings from -20 + dbm. (0 dbm= .001 watt.)		
Figure 6-11	Waveguide to Coax adapter			
Figure 6-11	Detector Mount	Maximum VSWR 1.25 Frequency Range 4-6 kmc - Waveguide size 2" x 1"		
Figure 6-11	Detector Mount	Maximum VSWR 1.25 Frequency 5.5 - 8.5 Kmc Waveguide size 1-1/2" x 3/4		
Figure 6-11	Tunable Bolometer Mount			Used in conjunction with power indicator to measure power.
Paragraph 6-25	Indicating Frequency Meter			

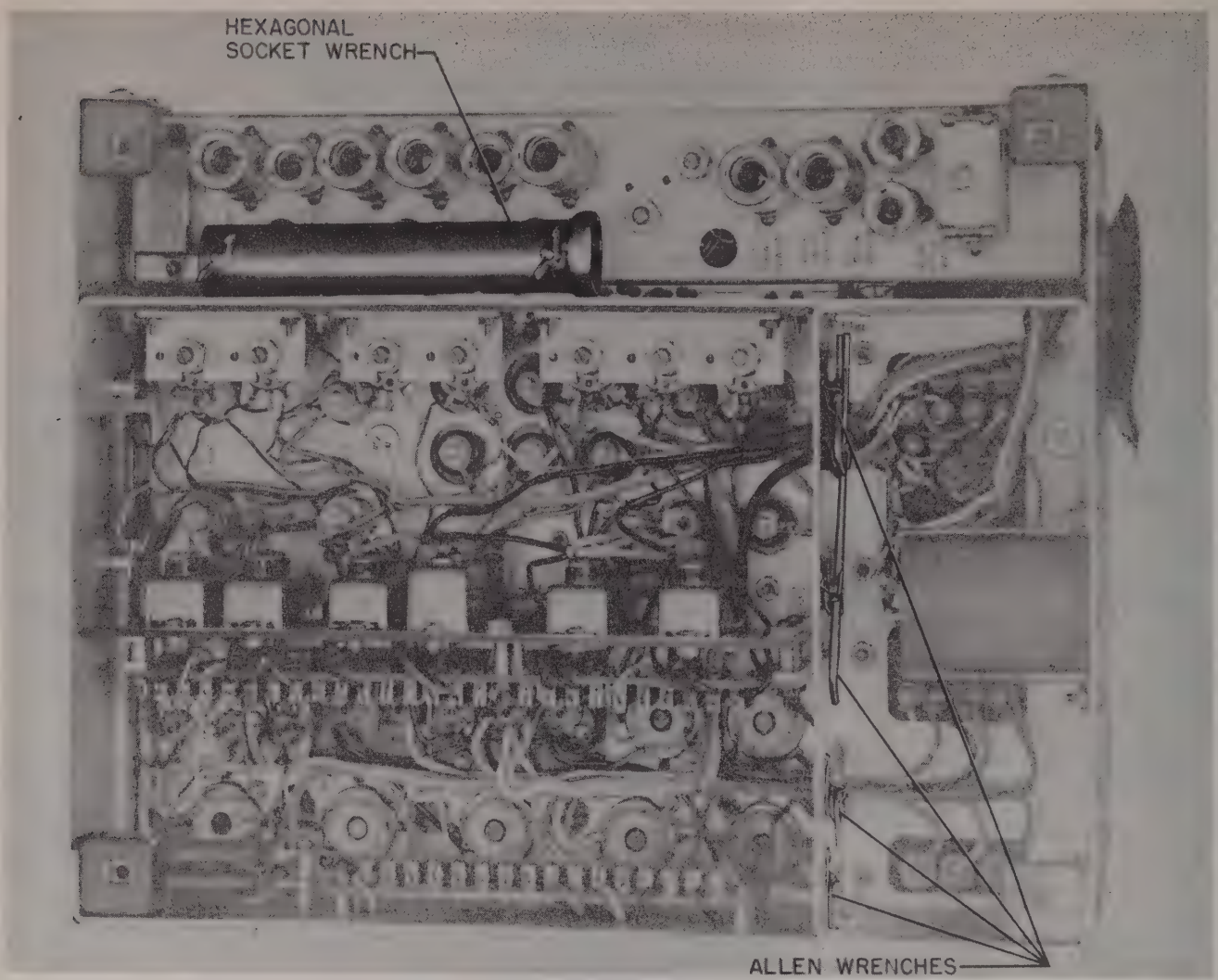


Figure 2-1. Location of Special Tools

2-3. No special tools are required, other than those illustrated in figure 2-1, which are supplied with the equipment. Shown in the illustration are one special hexagonal socket wrench and four Allen wrenches. The socket wrench is used to remove the hex nut at the entrance to the resonator when changing the klystron, V-114. The longest Allen wrench will be found helpful in removing cap screws holding klystron socket housing to resonator.

SECTION III

PREPARATION FOR USE AND RESHIPMENT

3-1. PREPARATION FOR USE.

3-2. The lid of the equipment's transit case is held in place by means of eight trunk latches. After removing the lid, place the transit case on the floor or a low table to facilitate removal of the instrument, which rests freely on rubber mounts on the bottom of the transit case. The accessory cables and cords are stored on the bottom of the transit case under the signal generator. Check to see that all items shown in figure 1-1 or 1-1A are present.

3-3. All controls and indicators referred to in the following steps are the same as those called out in figure 1-2 or 1-2A. Proceed as follows:

a. Locate the equipment so that the louvres on the cabinet are clear of walls or other equipment in order to secure free intake and exhaust of air by the blower unit within the cabinet.

b. Remove cables and cords from transit case.

c. Place the ON switch in its down, or off, position. This is the normal position of this switch when the equipment is not in use.

d. Connect power cable between POWER INPUT connector on front panel and source of power. Make certain that power source is nominal 115 volt, 50 to 1000 cps, single phase alternating current.

e. When the connection from the instrument to the required power source has been completed, the HEATER indicator, located to the left of the ON switch on the front panel, will light, indicating that electrical power is being supplied to the POWER INPUT connector of the signal generator.

f. Connect RF Cable CG-92D/U (6'0") to RF OUTPUT connector.

3-4. The following table shows the connections of all the cables:

Quantity	Cable		Purpose	Connected	
	AN/URM-52	AN/URM-52A		From	To
1	CX-337/U	CX-3135/U	Power Input cable	POWER INPUT connector	116 volt, 50 to 1,000 cycle, a-c source.
1	CG-92D/U	CG-92D/U	Output cable	RF OUTPUT connector	Equipment under test.
2	CG-409	CG-409	External synchronizing and modulating connecting cable	EXT. MOD., SYNC IN, SYNC OUT, or DELAYED SYNC OUT connectors (any 2)	External modulating and synchronizing equipment, or equipment to be synchronized.

3-5. WARMING UP THE EQUIPMENT.

3-6. Place ON switch to ON and MOD.SELECTOR switch to CW. Heater indicator on front panel will go off, POWER indicator will light and sound of blower motor will be heard. After approximately 30 seconds, needle of POWER SET meter should begin to move after approximately 2 minutes (time required for delay relay to operate) proceed as follows:

a. Place the MOD. SELECTOR switch to OFF. Adjust ZERO SET control so that needle of meter is in ZERO SET position.

b. Return MOD. SELECTOR switch to CW. Adjust POWER SET control until needle of meter rests on red line at center of scale, 0 DBM.

c. Allow the equipment to stand for approximately 10 minutes with MOD. SELECTOR switch on CW.

d. By means of POWER SET CONTROL readjust needle of POWER SET meter to 0 DBM.

e. When needle remains on 0 DBM with little deviation signal generator has reached a stabilized temperature and is ready for use.

3-7. PREPARATION FOR RESHIPMENT.

3-8. The following procedure should be employed when preparing the equipment for reshipment.

a. Place the transit case on the floor with the open end upward.

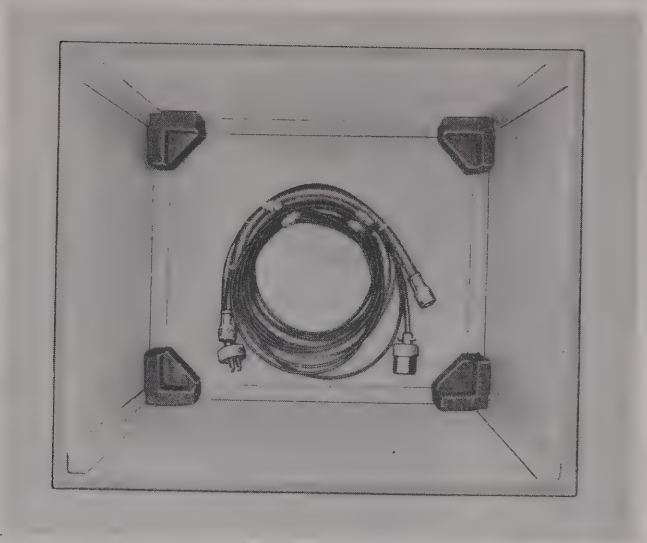


Figure 3-1. Location of Accessories in Transit Case

b. Disconnect all cables from connectors on panel and neatly roll each cable so that all will fit into bottom of transit case as shown in figure 3-1.

c. Carefully slide the signal generator into transit case, making sure back of signal generator rests securely on the sponge rubber shockmounts.

d. Fasten top of transit case in position, and secure in place with the eight trunk latches provided.

SECTION IV

THEORY OF OPERATION

4-1. GENERAL SYSTEM OPERATION.

4-2. To provide the types and ranges of outputs summarized in paragraph 1-7, the signal generator contains the six basic circuit elements shown in the System Block Diagram, figure 4-1. These are:

a. Synchronizing Circuits to establish the repetition rate of the modulation pulse applied to the r-f oscillator.

b. Modulator Circuits to develop a positive pulse, operating bias or cutoff bias to be applied to the klystron modulator grid.

c. An r-f Oscillator Circuit which receives the positive modulation pulse and generates the r-f output pulse.

d. Output Attenuator, a coupling system that adjusts the r-f output to the desired power level.

e. Power Monitoring System to monitor the power level existing in the r-f oscillator, and to provide a reference level from which to calibrate the output power level.

f. Power Supply Circuits which develop the operating voltages employed by the electronic circuit elements of the generator. Various types of modulation are possible by operation of the panel switches. Provisions are incorporated in the generator to disconnect the internal modulation circuits and to employ externally developed modulation voltages when desired. The detailed operation of the basic circuits, as well as circuit variations possible, are described in the following paragraphs.

4-3. FUNCTIONAL OPERATION OF ELECTRONIC COMPONENTS.

4-4. R-F OSCILLATOR SYSTEM.

4-5. KLYSTRON CONSTRUCTION AND OPERATION. The r-f oscillator develops the r-f output voltage that is applied to the load. The oscillator employs a type 6236 reflex klystron and a tunable parallel plane line section as a resonant tank circuit. The conventional equivalent electrical circuit is shown in figure 4-2. The resonant line circuit is connected between the two resonator grids of the klystron tube. The grid located between the resonator grids and the cathode is the modulator grid. It controls the flow of electrons from the cathode when a positive modulation pulse is present. The resonator and modulator grids are of open construction so as to present little physical opposition to the passage of electrons through them when electrical conditions are favorable. The electrode at the end of the tube is the repeller, and a voltage is placed upon it that is negative with respect to the resonator grids. This repels the electrons back towards the resonator grids.

4-6. OSCILLATION. When the circuit is in oscillation, the potentials at the two resonator grids are continuously changing at a rate equivalent to the frequency of oscillation. This causes some electrons to be accelerated, while others are decelerated during their passage through the grids. The result is that the electron stream is broken up (the electrons "bunched") into sections of heavy and light density in the area between the grids and the repeller. The distance that the bunched electron stream will travel beyond the resonator grids and their rate of travel after they have been repelled by the negative repeller electrode is determined by their initial speed and by the value of negative voltage on the repeller. Oscillation is sustained when these factors are adjusted so that the bunches of electrons arrive back at the resonator grids when the oscillating voltage at these grids is such that it opposes the passage

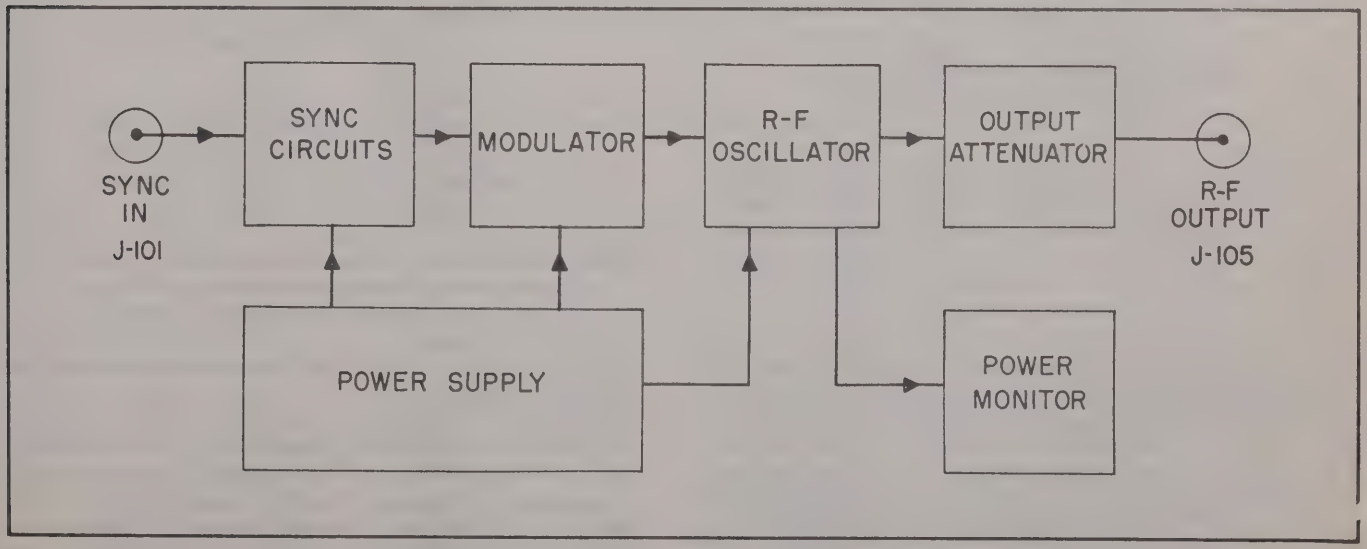


Figure 4-1. Signal Generator Block Diagram

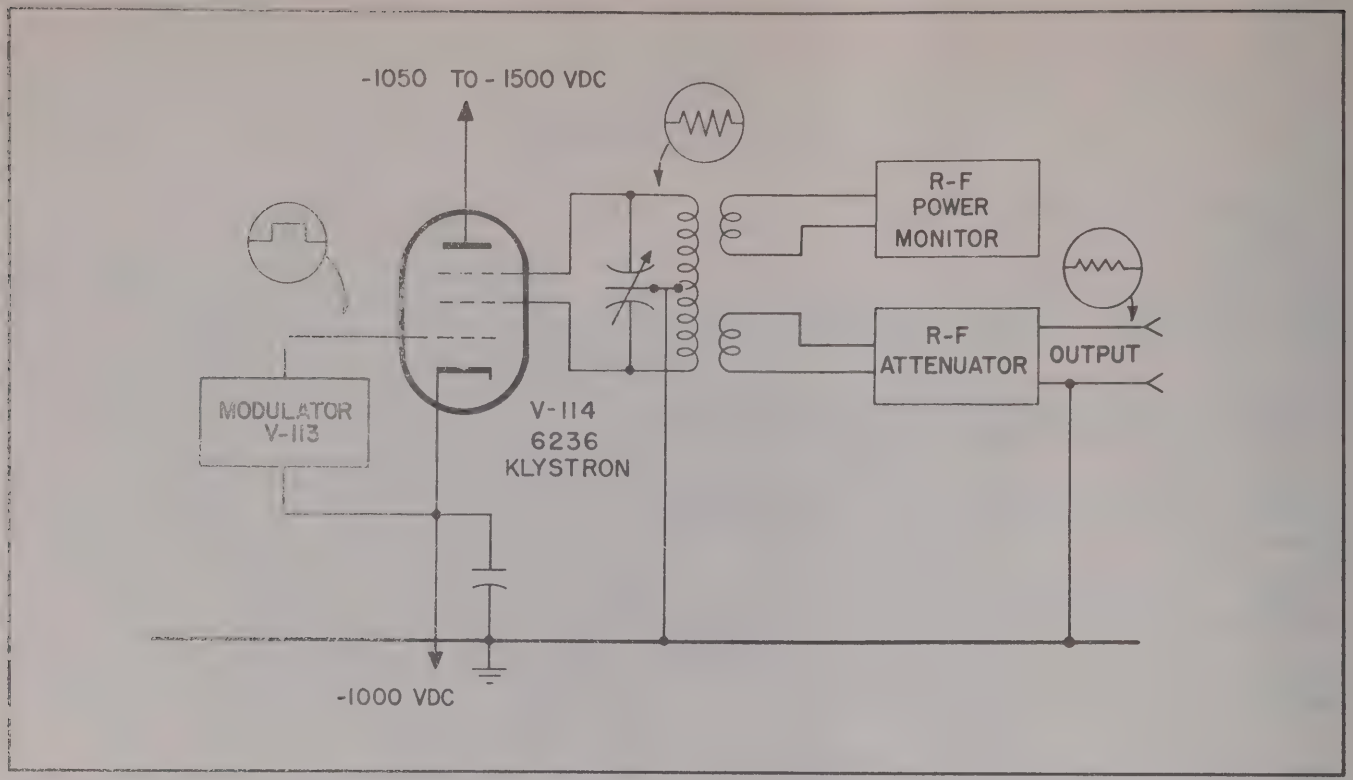


Figure 4-2. Equivalent Circuit of R-F Oscillator

of electrons. The electrons supply r-f energy to the cavity by virtue of the fact that they are slowed down by this alternating field between the resonator grids. When the electrons are collected by the resonator grids they become anode current.

4-7. POWER MONITOR AND ATTENUATOR. Two pickup loops are located in the tank circuit to collect r-f power. The first is the output attenuator loop which couples the power to be supplied by the generator to the load through an output connector on the panel. The position of this loop is adjustable so that the output power level may be varied as desired. The second is the power monitoring loop that monitors the power level in the oscillating circuit and establishes a reference point to calibrate the output power.

4-8. PARALLEL PLANE RESONATOR.

4-9. DESCRIPTION. The tank circuit employed in the signal generator is known as a parallel plane resonant line. In its physical shape it resembles a rectangular box type cavity with a circular center element and a rectangular plunger to vary the cavity depth. Actually the line is a direct development from a circular coaxial line as shown in figure 4-3. Part A of figure 4-3 shows such a line, and the electric and magnetic field configurations that exist when it is excited electrically. The concentric circles in part A and the concentric ellipse in part B, of the figure 4-3, represent the magnetic field while the radial lines essentially at right angles to the lines representing the magnetic field represent the electric field. The oscillating frequency of such a line with one end shorted is determined by its electrical length in a direction parallel to the center conductor. The other dimensions

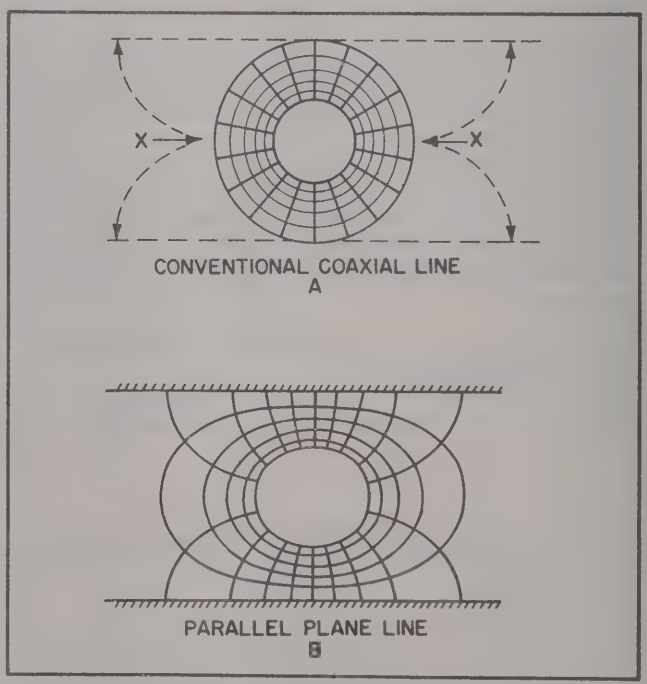


Figure 4-3. Field Configuration of Coaxial and Parallel-Plane Lines

of the line play a very small part in determining the oscillating frequency.

4-10. DEVELOPMENT. The evolution of the parallel plane line from the coaxial line may be understood by reference to figure 4-3, parts A and B. Assume the outer conductors were cut at the points "X" and the two semi-lines thus created were flattened out as

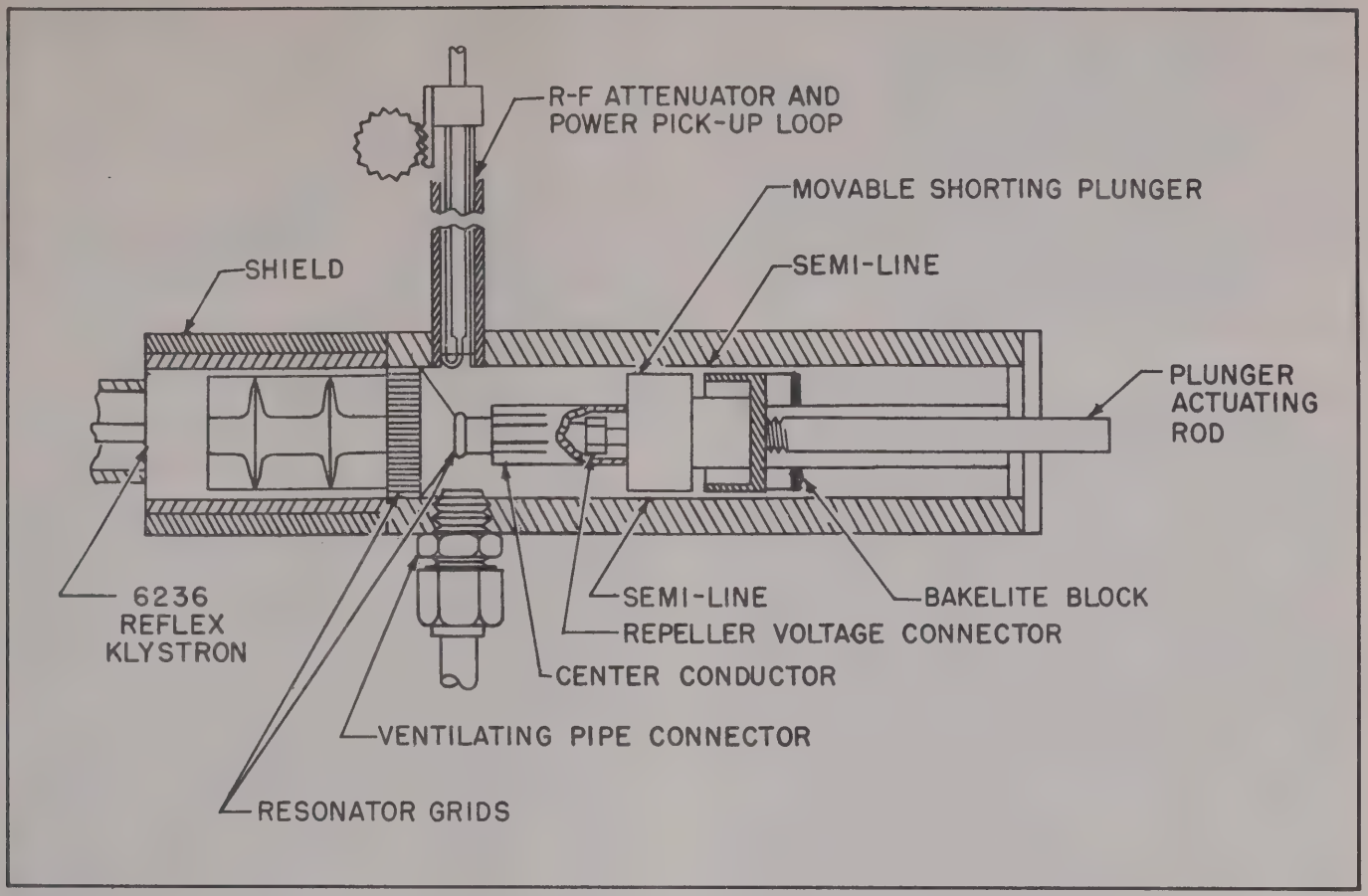


Figure 4-4. Cutaway View of R-F Oscillator

shown by the horizontal dotted lines. The electric and magnetic field configurations would then take the form shown in part B. To carry this example through in complete detail would require that the cross-section of the center conductor take a slightly elliptical form for perfect configurations. However, for practical purposes, this is not necessary, and a circular center conductor is used. The line, as shown in figure 4-3, part B, is not enclosed on the short sides, and it is possible to operate it in this manner. However, in the signal generator, sides are provided to prevent stray r-f leakage currents.

4-11. BASIC OPERATION OF RESONATOR. The parallel plane line depends, for its resonant frequency, upon its electrical length and consequently may be tuned by simple mechanical means and can be directly calibrated. This type of cavity provides a resonator in which simple and straight-forward methods can be employed to provide broad band suppression of the various parasitic resonances which occur when other physical dimensions approach the frequency-determining electrical dimensions. Figure 4-4 shows a cut-away view of the resonant line and the other components of the parallel plane oscillator as employed in the signal generator. The type 6236 reflex klystron is mounted so that one of the resonator grids is coupled to the two semi-lines while the other is coupled to the circular center conductor. The repeller voltage is applied through an insulated filter in the center conductor while the other potentials required to operate the tube are applied through the tube base pins.

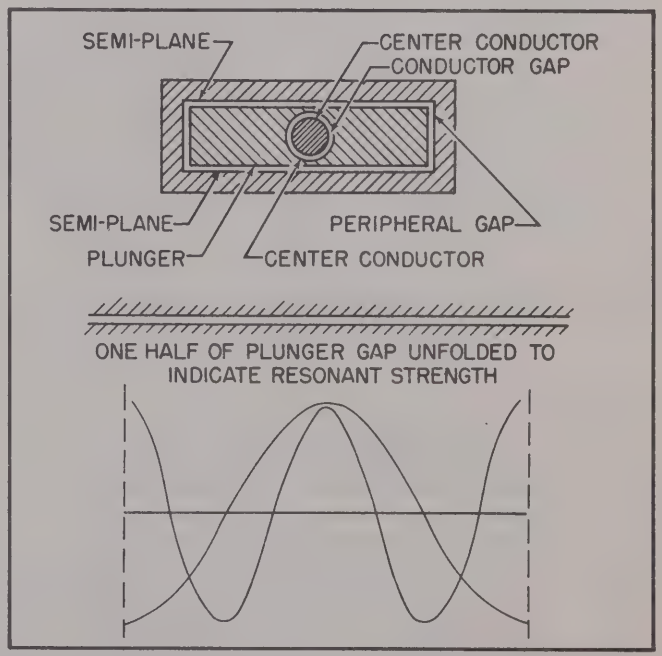


Figure 4-5. Plunger Resonances in Uncompensated Parallel-Plane Line Resonator

4-12. PLUNGER RESONANCES. The plunger employed in the parallel plane resonator is of the non-contacting type and a small air gap exists between the periphery of the plunger and the surfaces of the semi-planes and sidewalls, as shown in figure 4-5. This gap has a

physical length of approximately 17 centimeters, and an electrical length such that it has a two-cycle resonant frequency occurring near and a four cycle resonant frequency occurring within the frequency range of the oscillator. As shown in figure 4-5, these frequencies correspond to one-half and one quarter of the electrical length of the periphery of the plunger. A similar gap exists between the center conductor and the plunger. However, the length of this gap is such that no resonances occur in the frequency range of the oscillator. Compensation is applied to prevent resonance of the line formed by the peripheral plunger gap in the resonator employed in the signal generator.

4-13. FREQUENCY PLOT OF UNCOMPENSATED RESONATOR. Figure 4-6 shows a frequency plot of an uncompensated parallel plane resonator covering the range between 3,800 and 7,500 megacycles per second. It indicates that four resonances may exist throughout portions of the frequency band. Two of these peripheral plunger resonances will be found at approximately 3,500 and 7,000 megacycles per second. Since these resonances are due to the distance around the periphery of the plunger, they are unaffected by the position of the plunger in the resonator. The presence of these resonances is highly undesirable, since they tend to absorb power, usually damping out the desired oscillation and causing a dead or reduced power spot in the tuning range when the resonator is tuned to their approximate frequencies. The desired frequencies of operation, plotted in relation to the percentage of total plunger travel is indicated by the upper heavy slanting line in figure 4-6. The voltage applied to the repeller electrode of the type 6236 klystron is such that the tube operates in the 2-3/4 repeller (2,2) mode throughout the entire frequency range of the signal generator. An interfering resonance is shown by the lower sloping line. It consists of a higher-order mode that tends to track with the desired mode throughout the tuning range. A condition is established where the (3,3) mode very closely follows the (2,2) mode. The partial mode plot of the oscillator shown in figure 4-7 shows the close proximity of the undesired and desired modes throughout their entire frequency range.

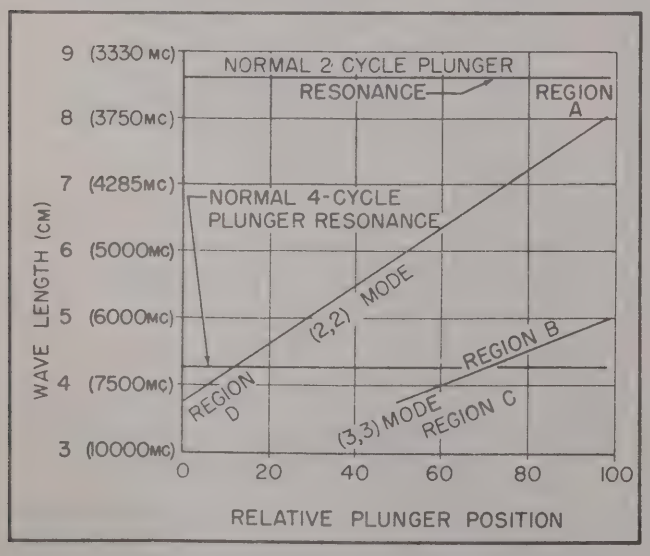


Figure 4-6. Frequency Plot of Uncompensated Resonator

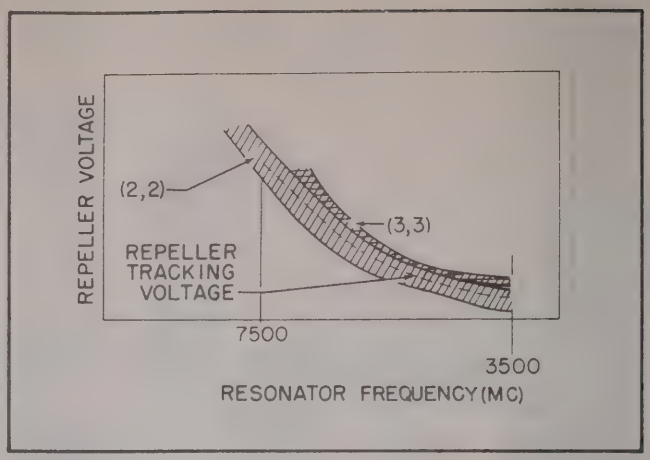


Figure 4-7. Partial Plot of Klystron Modes

4-14. RESULT OF USING UNCOMPENSATED PLUNGER. The result of employing the resonator without compensation would be that two oscillating frequencies could be obtained at practically all settings of the plunger. This would cause a highly unstable oscillating condition to exist, with the circuit oscillating at one of the possible frequencies, then shifting to the other and back again, between modes. This condition would be especially pronounced during pulse modulation. The two horizontal lines show the two-cycle and four-cycle resonances of the peripheral plunger gap. At the low-frequency end of the range, the desired resonance approaches the two-cycle plunger resonance, while the desired resonance actually coincides with and crosses the four-cycle plunger resonance at approximately 7000 megacycles per second. When the desired resonance approaches plunger resonance the plunger loads the oscillating circuit, often to the point where the desired resonance is completely damped out, causing reduced power or dead spots to appear in the tuning range. The method of compensation employed to eliminate undesired resonances is described in the following paragraphs.

4-15. RESONATOR AND PLUNGER COMPENSATION.

4-16. GENERAL. In order to compensate for the various undesired resonances shown in figure 4-6 and 4-7, the electrical length of the resonant line around the periphery of the plunger is caused to vary as the plunger is moved physically between the semi-planes. Figure 4-8 shows a compensated frequency plot of the resonator obtained this way. In region B at the low-frequency end of the tuning range the electrical length of the peripheral line is increased in such a manner that the four cycle resonant frequency of the plunger coincides with the frequency of the (3,3) modes throughout this range. This completely damps out oscillations in these modes by loading the oscillating circuit so heavily that oscillation cannot be sustained. Figure 4-8 also shows the lowering of the frequency of the two-cycle plunger resonance so that, in region A, a much greater frequency difference exists, and no damping action can take place.

4-17. UPPER AND LOWER WALL SLOTS. The manner in which this is accomplished is shown in figure 4-9. Slots are placed in the resonator walls. These slots

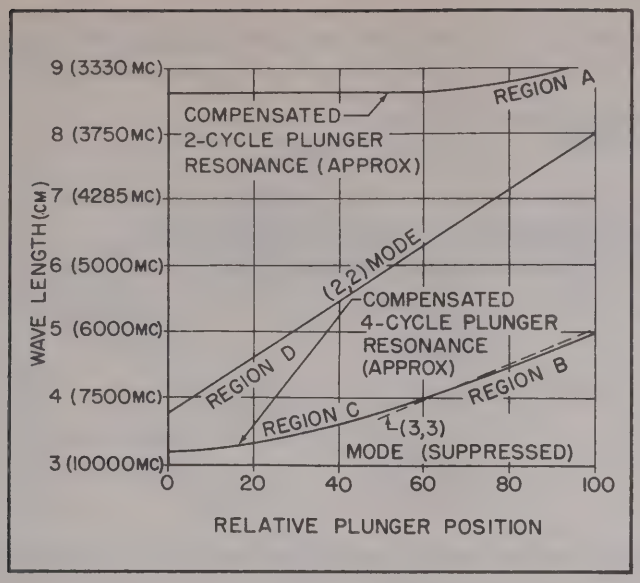


Figure 4-8. Frequency Plot of Compensated Resonator

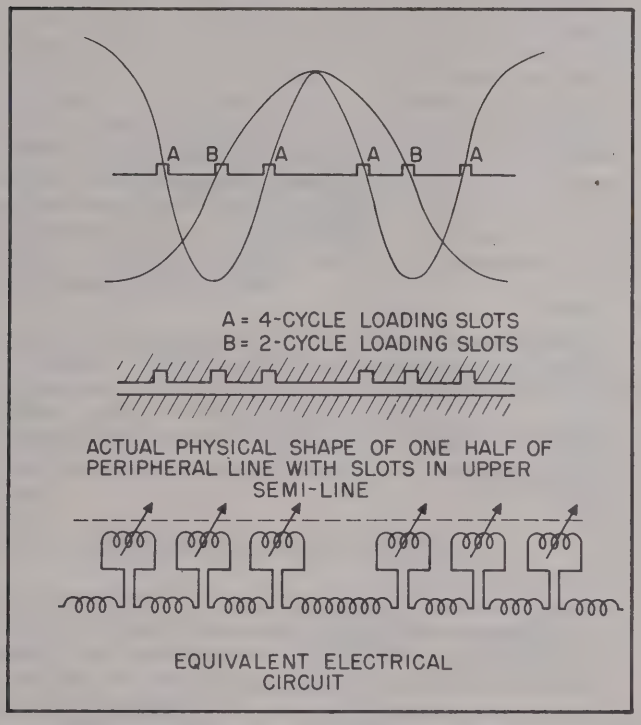


Figure 4-9. Compensation of Plunger Resonance at Lower Frequencies

inductively load the peripheral resonant line, increasing its electrical length and lowering its resonant frequency to coincide with the (3,2) mode. The depth of these slots is tapered so as to cause the peripheral resonance to coincide with the undesired resonance as the plunger is moved. An equivalent electrical circuit, using conventional inductance symbols is shown on figure 4-9. In region C, the four-cycle plunger resonance is higher than the undesired (3,3) mode. It is necessary to shorten the electrical length of the peripheral line to track with this mode. Figure 4-10 shows the manner in which this is accomplished.

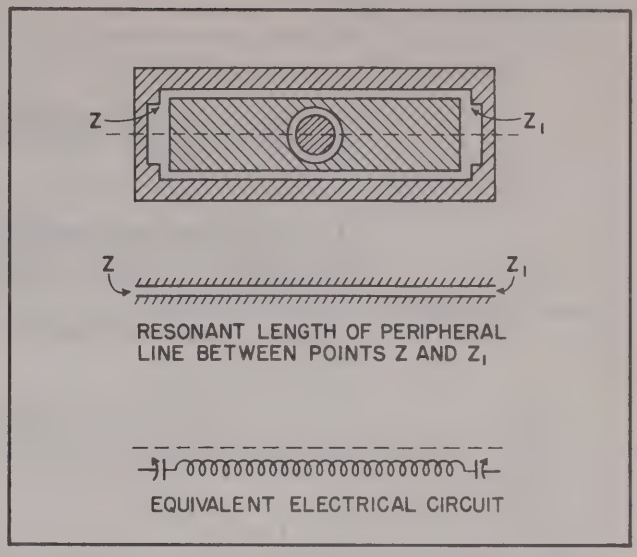


Figure 4-10. Compensation of Plunger Resonance at Higher Frequencies

4-18. SIDE WALL SLOTS. Slots are placed in the side walls of the resonator. These slots present a capacitive reactance, acting as high impedance sections and presenting a high impedance to the line at the points Z and Z1. This reduces the electrical length of the line and raises its resonant frequency. By varying the width and depth of these slots, the peripheral resonance is made to track with the frequency of the (3,3) mode in region C, effectively damping the undesired oscillation in this mode. The effect of these slots in the side walls is continued in region D, and utilized to further raise the frequency of the peripheral line so that its frequency remains considerably higher than the desired frequency in the (2,2) mode, thus avoiding the damping effects that would take place with an uncompensated line.

4-19. REPELLER VOLTAGE CONTROL.

4-20. GENERAL. The operating characteristics of a reflex klystron are such that an optimum value of repeller voltage exists for each operating frequency. This voltage is the value which will cause the bunched electrons to return to the resonator grids at the proper time. Figure 4-11 shows the repeller voltage characteristics for the type 6236 klystron over the range employed in the signal generator.

4-21. REPELLER VOLTAGE CHARACTERISTICS. The repeller voltage characteristics shown in figure 4-11 provide for operation in the 2-3/4 repeller mode. The voltage required for optimum operation varies linearly with frequency for the frequency range above 4400 megacycles per second. In the frequency range from 3800 to 4400 megacycles per second the required voltage is not a linear function of frequency but is slightly curved as shown.

4-22. REPELLER VOLTAGE CIRCUIT. Figure 4-12 shows the circuit that provides negative voltage to the repeller. R-174 is a 100,000 ohm wire-wound potentiometer that is mechanically ganged with the mechanism that tunes the resonant line, providing the proper

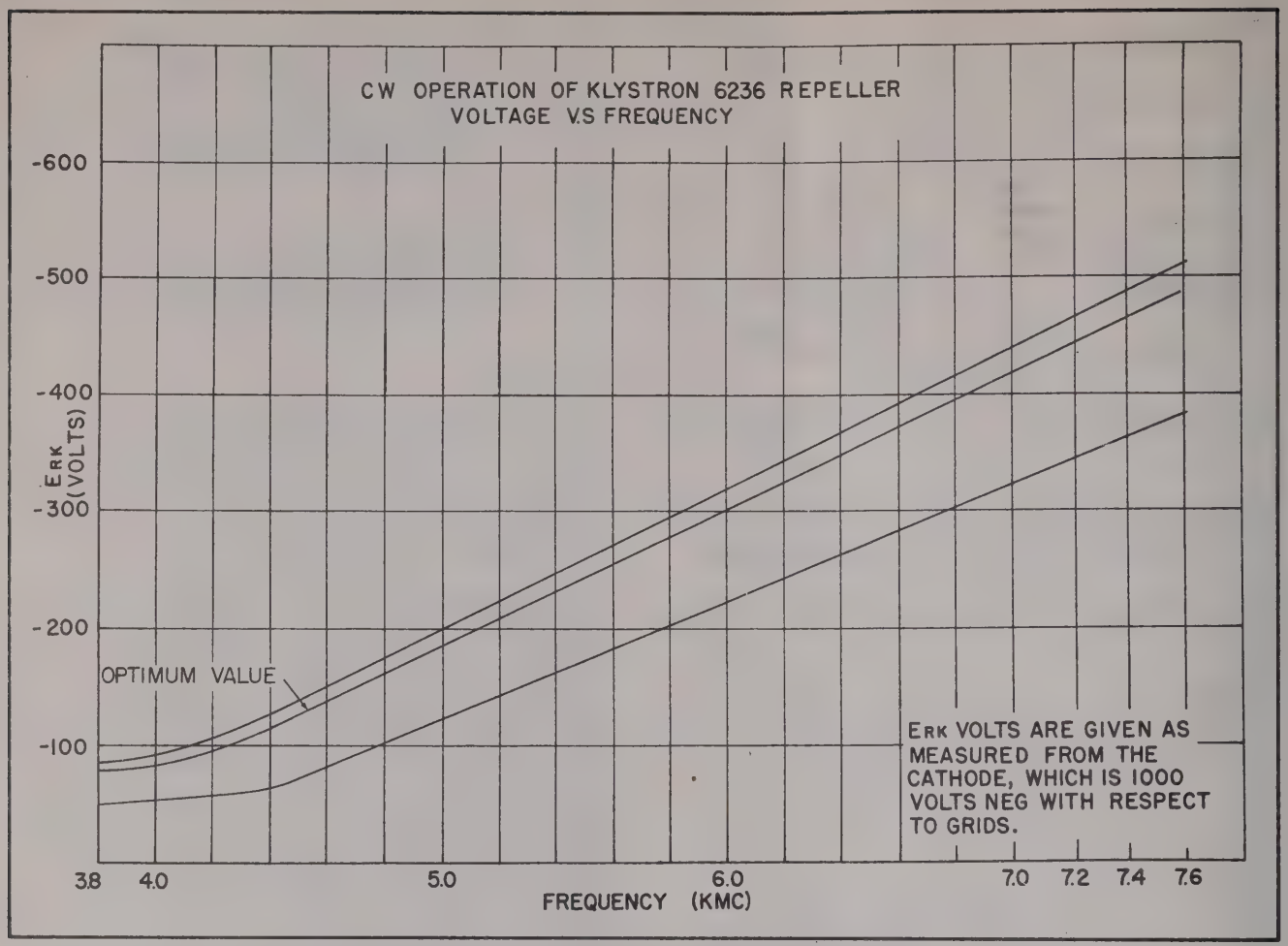


Figure 4-11. Plot of Repeller Voltage vs Frequency

voltage to the repeller electrode as the frequency is changed. The value of resistors R-170, R-175, R-173 and R-178 and adjustable to establish the voltage applied across repeller tracking potentiometer R-174.

4-23. COUPLING METHODS.

4-24. GENERAL. Power is coupled to the load from the r-f oscillator by a coupling loop located at a high impedance point in the resonant line. This loop slides in a circular waveguide section. (See figure 4-4.) The cross section of the waveguide is very small in relation to the frequencies of operation, and normal propagation down the waveguide will not take place. However, some limited propagation does take place, and the power level decreases exponentially as the distance from the resonant line increases. Thus it is possible, by moving a pickup loop linearly in the waveguide to secure an output that varies in decibels in proportion to the linear travel. This type of attenuator is known as an attenuator of the cut-off type and its characteristics are employed so that the pick-up probe and indicating dial can be moved by a simple gear train and the dial may be calibrated linearly in decibels.

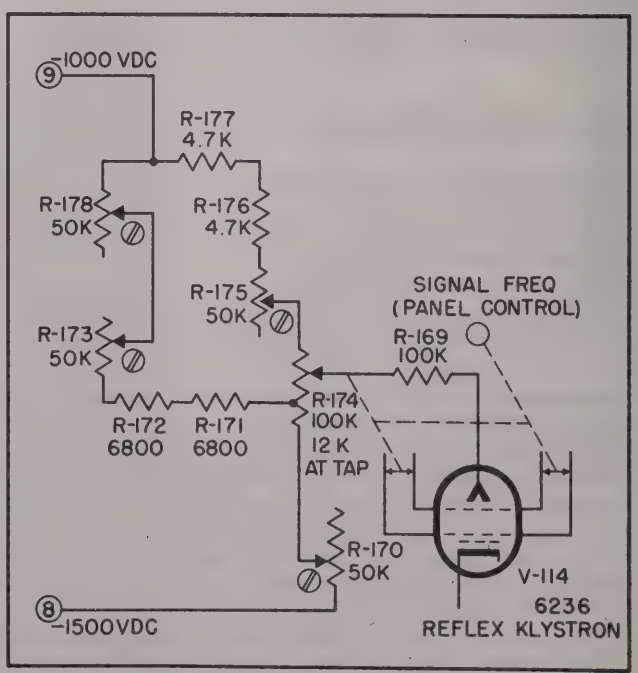


Figure 4-12. Simplified Schematic of Klystron Repeller Voltage Tracking Circuit

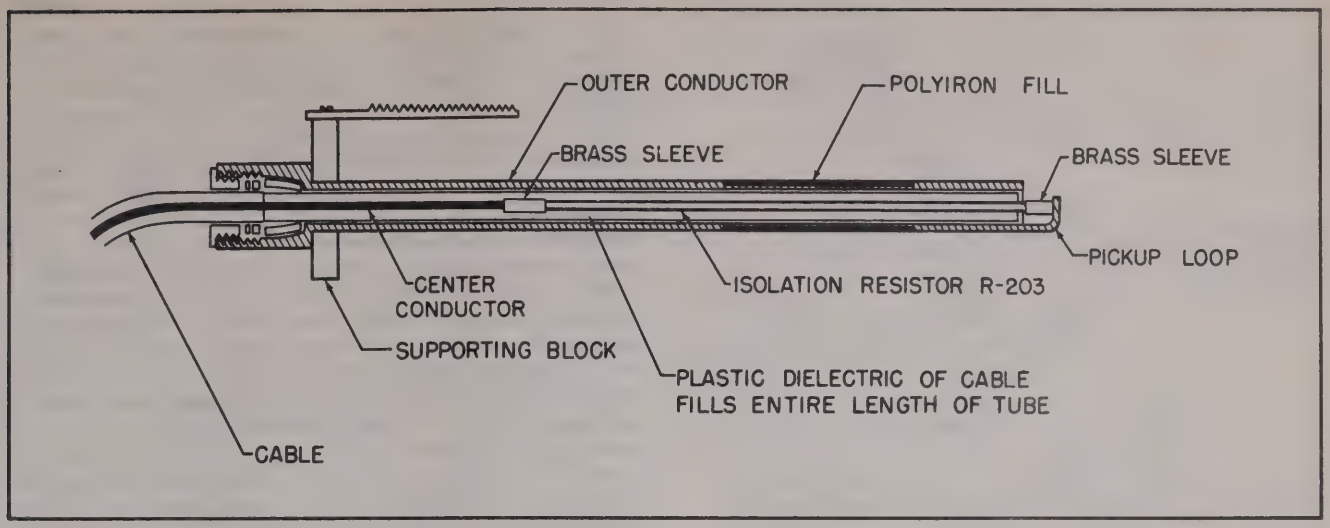


Figure 4-13. Cutaway View of Attenuator Probe

4-25. CONSTRUCTION OF ATTENUATOR ASSEMBLY. A cross-section of the attenuator and r-f pick-up loop is shown in figure 4-13. The pick-up loop couples r-f energy from the waveguide section. The assembly consists of an external metal conductor covering a section of RG-55/U cable, replacing the outer shield. A three-inch section of the center conductor has been removed and is replaced by resistor R-203. This resistor is made by plating platinum on a 1/32-inch diameter glass rod, and its value is such that it introduces a 10 db loss in the line. Its d-c resistance is approximately 100 ohms.

4-26. OPERATION OF ATTENUATOR ASSEMBLY. The purpose of resistor R-203 is to stabilize the source impedance of the signal generator at 52 ohms. The polyiron section on the outside of the probe is designed to absorb power that may leak past the probe in the space between the outer conductor and the waveguide walls.

4-27. POWER MONITOR SYSTEM.

4-28. GENERAL. The power generator by the oscillator varies with frequency, primarily because of the characteristic of klystrons. Therefore, a power monitor circuit is included to indicate the level of the field at the attenuator input.

4-29. POWER MONITORING PROBE. The power monitor r-f probe, shown in figure 4-14 is constructed similarly to the attenuator probe, except that a bead thermistor R-202 is located at the end of the probe, and no resistor is placed in the line. This bead thermistor acts as a power-metering bolometer when employed in the bridge circuit described in paragraph 4-30.

4-30. POWER MONITOR CIRCUIT. The power in the resonator is monitored by the thermistor bridge circuit shown in figure 4-15. The bead type thermistor R-202, which is one arm of the bridge, is located at the tip of the piston type probe described in paragraph 4-29. This thermistor absorbs a small amount of power from the resonator. The resistance of the bead is in turn changed by the heat developed within the bead itself. This change unbalances the bridge causing the meter to give an upscale reading. The monitoring circuit also employs two disk type thermistors for temperature and sensitivity compensation.

4-31. CIRCUIT OPERATION. The bridge is balanced for d-c conditions. When r-f power from the resonator is applied to the thermistor, the bridge becomes unbalanced. The balance indicating device is M-101, a 200 microampere meter, connected across the bridge to indicate circuit balance. R-201 is a disc-type thermistor connected in parallel with the meter and it acts as a

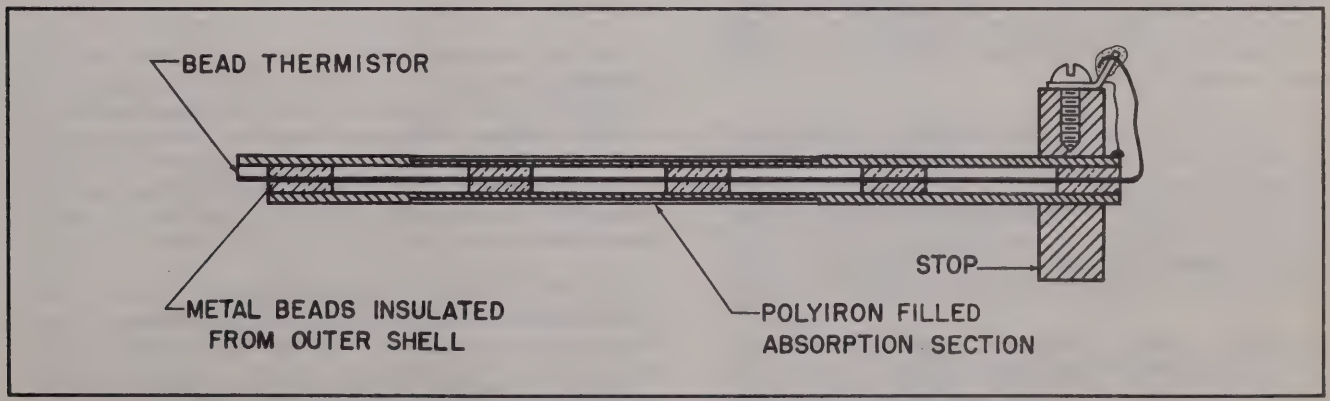


Figure 4-14. Cutaway View of Power Monitor Probe

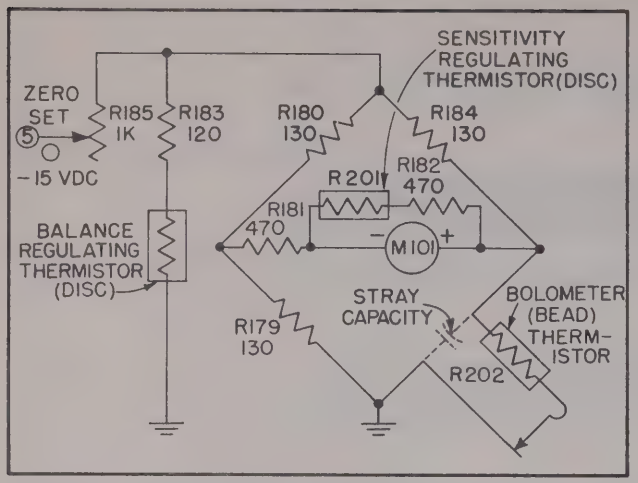


Figure 4-15. Simplified Schematic of Power Monitor Circuit

sensitivity regulator to counteract the tendency of the bridge to decrease in sensitivity as the temperature of the bridge increases.

4-32. THERMAL COMPENSATION. A second disc thermistor, R-200 is shunted across the bridge in series with limiting resistor R-183. This acts as a balance regulating device to compensate for unbalance due to resistance changes in R-202 caused by variations in ambient temperature. An ambient temperature increase will cause the resistance of R-202 to decrease, causing more current to flow through its leg of the bridge, increasing the meter reading by unbalancing the bridge. R-200 will also decrease in resistance, causing a drop in the total voltage across the bridge and a decrease in current flow through its various legs, thereby decreasing the meter reading. Since the static resistance of R-202 is determined by both the ambient temperature and the static bridge current flowing through it, the decrease in bridge current caused by the actions of R-200 will act to decrease the temperature of R-200 and tend to restore the static balance of the bridge. This thermistor is mounted in a recess in the top of the resonator so that it is immediately sensitive to temperature changes.

4-33. R-F ISOLATION. R-F power at the bead thermistor is isolated from the bridge by means of a low pass filter consisting of metal beads spaced along the center conductor within the power monitoring probe. Polyiron fill, embedded in the outer surface of the probe, absorbs any r-f energy existing between the probe and its waveguide housing.

4-34. EMPLOYMENT OF POWER MONITORING SYSTEM. The power monitor probe is moved within its waveguide in a manner similar to the power attenuator pickup probe. Its position is controlled by the POWER SET control on the front panel and is indicated by the position of the transparent index scale over the calibrated OUTPUT ATTEN. (attenuator) dial.

4-35. OPERATION OF POWER MONITOR AND ATTENUATOR SYSTEMS. The power level existing at the location of the probes in the resonator varies as the signal generator is tuned over its frequency range. To compensate for this, the penetration of the power monitor probe should be changed by operation of the POWER SET control so that it picks up the amount of power necessary to hold the POWER LEVEL meter at 0 dbm. This establishes the basic reference level for 1 milliwatt and positions the transparent index scale over the attenuator dial. The OUTPUT ATTEN. control is then adjusted with reference to this index scale to provide the desired attenuation below 1 milliwatt as read on the calibrated dial. The OUTPUT ATTEN. control moves the output attenuator probe mechanically and also moves the calibrated dial. Thus when any calibration point on the dial is under the index line, the position of the output probe in its waveguide is proportional to that of the power indicating probe (which has been set to the proper reference level) and the power output may be read directly on the dial. Movement of the output probe in its waveguide will cause attenuation as described under paragraph 4-23. The power indicating dial is calibrated in decibels below one milliwatt when coupled to a 52-ohm load.

4-36. MODULATOR SECTION.

4-37. BLOCK DIAGRAM. The modulator section is shown in block diagram form in figure 4-16. The function of the circuits in this section is to establish a modulating pulse (for pulse operation) or a sawtooth voltage (for frequency modulation) and to apply it to the r-f oscillator so as to secure the desired type of r-f output. Various portions of these circuits are not employed in certain types of operation such as when external pulse or f-m modulation voltages are provided. However, the block diagram shows the condition where all of the circuits except the pulse rate multivibrator are employed (delayed pulse output with external synchronization) and the description will cover this type of operation. Other types of operation will be described in later paragraphs.

4-38. SYNC. IN AMPLIFIER AND INVERTER. The SYNC. IN amplifier V-101A and V-101B is designed to accept either sine waves or positive or negative synchronizing pulses. It converts sine waves into a steep negative wave front necessary to trigger the PULSE forming multivibrator V-104. With positive pulses it acts as an amplifier and inverter, since only one stage is in use. With negative pulses it acts as a straight amplifier, since two stages are used for this type of input. The input desired is selected by a switch on the control panel.

4-39. PULSE RATE MULTIVIBRATOR. The PULSE RATE multivibrator V-103A and V-103B is not used when external synchronization is employed. When internal timing is desired, the circuit constants are switched to make it a free-running multivibrator with a repetition rate adjustable from 40 to 4,000 cycles per second. Its output is a negative square wave with a very steep leading edge.

4-40. SYNC. OUT PULSE SHAPING MULTIVIBRATOR. The output of the PULSE RATE multivibrator is differentiated and applied to the SYNC. OUT pulse shaping multivibrator V-104A and V-104B. This circuit is a one-cycle multivibrator with a two-microsecond time constant that operates on the differentiated negative

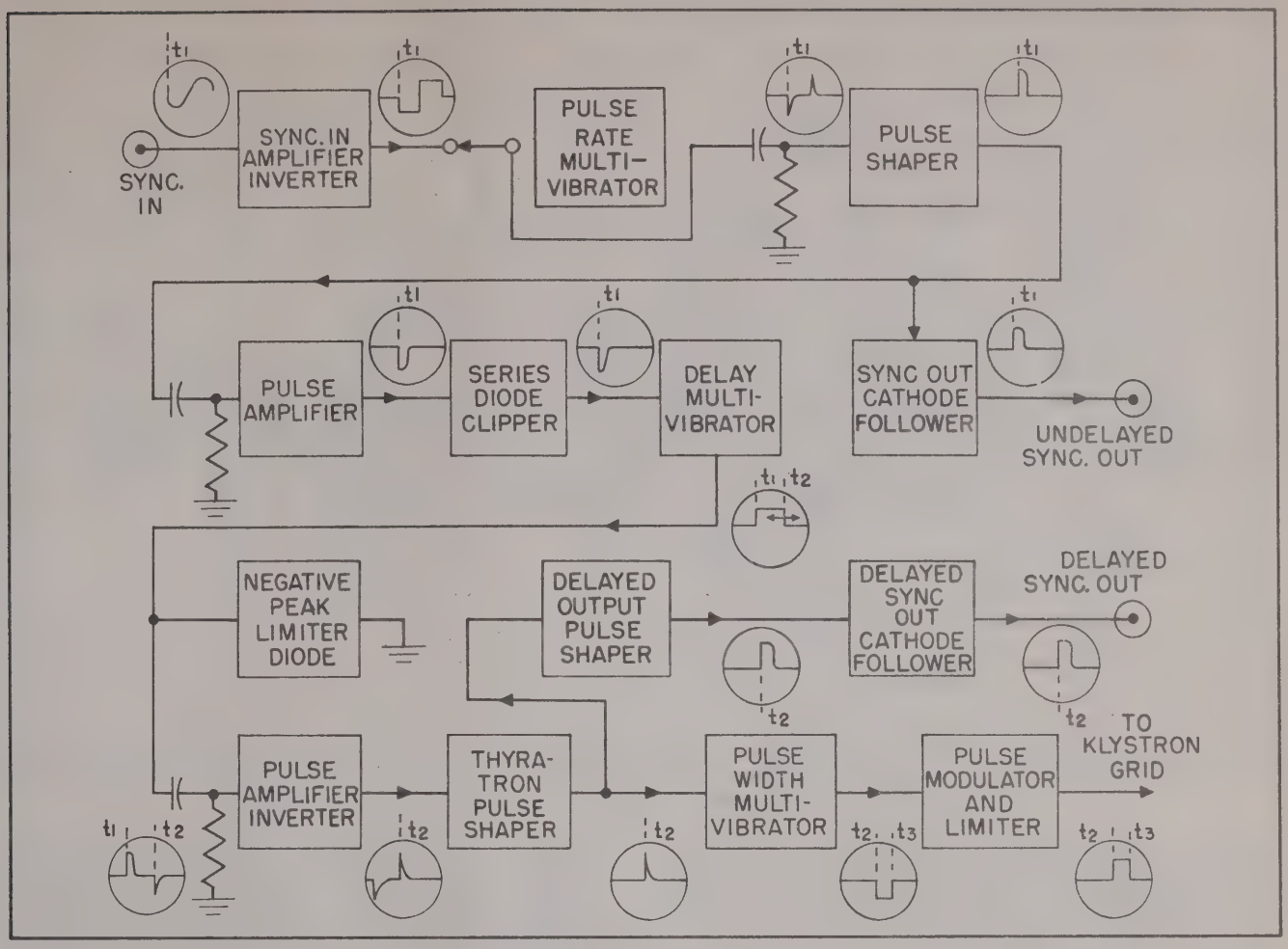


Figure 4-16. Block Diagram of Modulator Circuits

voltage pulse and produces a positive pulse of two-microseconds duration.

4-41. PULSE AMPLIFIER. The voltage from V-104 is applied to the pulse amplifier V-105A to produce a negative output pulse of two-microseconds duration. The voltage from the pulse shaping multivibrator is also applied to the SYNC. OUT cathode follower V-105B and provides the undelayed voltage pulse available at the SYNC. OUT connector for synchronizing external equipment.

4-42. PULSE DELAY MULTIVIBRATOR. The output of the pulse amplifier is applied to the PULSE DELAY multivibrator V-107A and V-107B through a series diode base limiter V-106A that removes any positive voltage transients and permits only the negative pulses of sufficient amplitude to be applied to the multivibrator. The delay multivibrator output is a positive rectangular pulse with the leading edge essentially coincident in time with the synchronizing voltage. The trailing edge appears at a later time (t_2) that is determined by the adjustment of the PULSE DELAY control on the front panel. From 3 to 300 microseconds delay may be provided between t_1 and t_2.

4-43. PULSE DELAY MULTIVIBRATOR BASE LIMITER. The negative base limiter diode V-106B acts to bypass negative transients following the trailing edge of the output of the PULSE DELAY multivibrator. This wave form is differentiated into a positive voltage spike at t_1 and a negative spike at t_2.

4-44. PULSE AMPLIFIER-INVERTER. The differentiated output of the PULSE DELAY multivibrator is applied to the pulse amplifier inverter V-109A which inverts it so that the negative spike appears at t_1 and the positive spike at t_2.

4-45. THYRATRON PULSE SHAPER. The Thyratron Pulse Former V-110 is based for non-conduction. The positive spike, however, causes the tube to ionize and conduct current at t_2.

4-46. DELAYED SYNC. OUT MULTIVIBRATOR. A positive voltage spike is taken from the cathode of V-110 and applied to the DELAYED SYNC. OUT multivibrator V-115A and V-115B and the PULSE WIDTH multivibrator V-111A and V-111B at t_2. The DELAYED SYNC. OUT MULTIVIBRATOR V-115A and V-115B develops a positive pulse, essentially 2 microseconds in duration.

4-47. DELAYED SYNC. OUT CATHODE FOLLOWER. The output from V-115B is supplied to DELAYED SYNC. OUT Cathode Follower V-109B. This stage acts as an

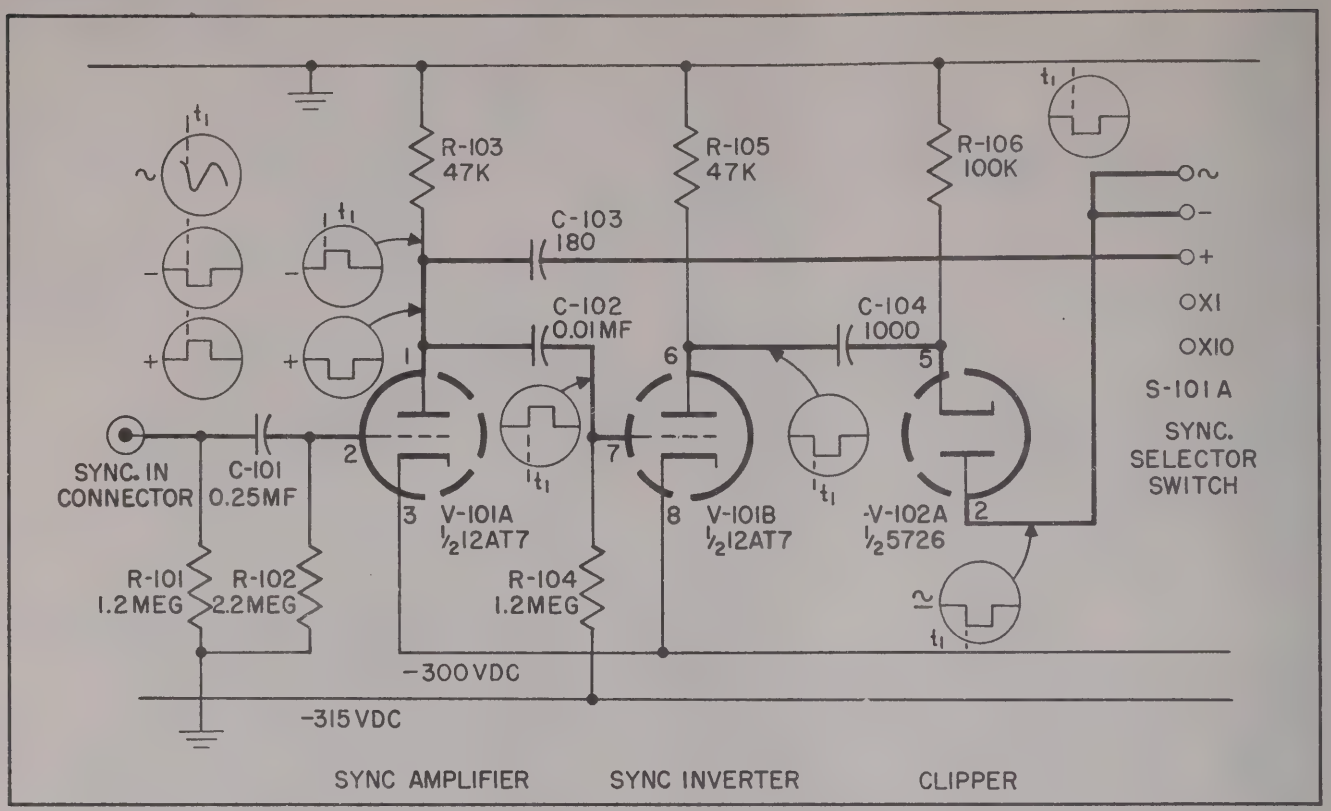


Figure 4-17. Simplified Schematic of Basic Sync Input Circuits

impedance transforming device and its output is a positive two-microsecond pulse at t_2 that is available at the DELAYED SYNC. OUT connector J-104 for synchronizing external equipment.

4-48. PULSE WIDTH MULTIVIBRATOR. The output of the thyratron pulse shaper when applied to the PULSE WIDTH multivibrator causes this circuit to develop a negative pulse with the leading edge appearing at t_2 and the trailing edge at t_3. The duration of the pulse is adjustable from 0.5 to 10 microseconds by the calibrated PULSE WIDTH control on the panel.

4-49. PULSE MODULATOR, CLIPPER, AND KLYSTRON GRID CLAMP. The negative pulse from the PULSE WIDTH Multivibrator is applied to the Pulse Modulator V-113. This stage amplifies and inverts the pulse and applies a positive pulse to the klystron grid, activating the tube during the period the pulse is present. Two diodes are employed in the modulator circuit. One is a positive peak clipper on the input circuit while the other acts as a bias regulator for the r-f oscillator circuits. The positive peak clipper protects the modulator tube by preventing any voltages more positive than a pre-determined value from reaching its grid. The diode bias regulator clamps the bias voltage on the klystron modulator grid to a value that establishes proper beam current for the klystron under any condition of modulation.

4-50. INTERNAL FREQUENCY MODULATION. Internal sawtooth voltage for application to the repeller electrode is developed by transforming the thyratron discharge circuit into a relaxation oscillator. When triggered by the PULSE RATE multivibrator, it generates a sawtooth wave as its output. The amplitude of this sawtooth wave is not controllable. However, the FM AMPLITUDE control on the front panel is used to adjust the amplitude of the sawtooth voltage applied to the r-f oscillator.

4-51. CONTINUOUS-WAVE OPERATION. CW operation is obtained by placing a fixed positive voltage on the klystron r-f oscillator accelerator grid to permit continuous operation.

4-52. EXTERNAL PULSE MODULATION. External positive pulses are applied through the pulse amplifier-inverter (figure 4-22) to the Pulse Modulator while external negative pulses are applied directly to the pulse modulator (figure 4-24).

4-53. EXTERNAL FM MODULATION. External frequency modulation voltages are applied directly to the repeller electrode of the klystron oscillator tube through the FM AMPLITUDE control on the panel and an isolation capacitor. Either sawtooth or sine wave voltage may be applied. Voltages required for external modulation at frequencies from 20 cps to 20,000 cps are connected to the EXT. MOD connector on the front panel.

4-54. DETAILED CIRCUIT DESCRIPTION.

4-55. SYNC INPUT CIRCUITS. These circuits accept the external synchronizing voltage applied at J-101, the SYNC. IN connector, and transform it into a negative pulse employed to trigger the PULSE shaping multivibrator V-104. The circuit elements are shown

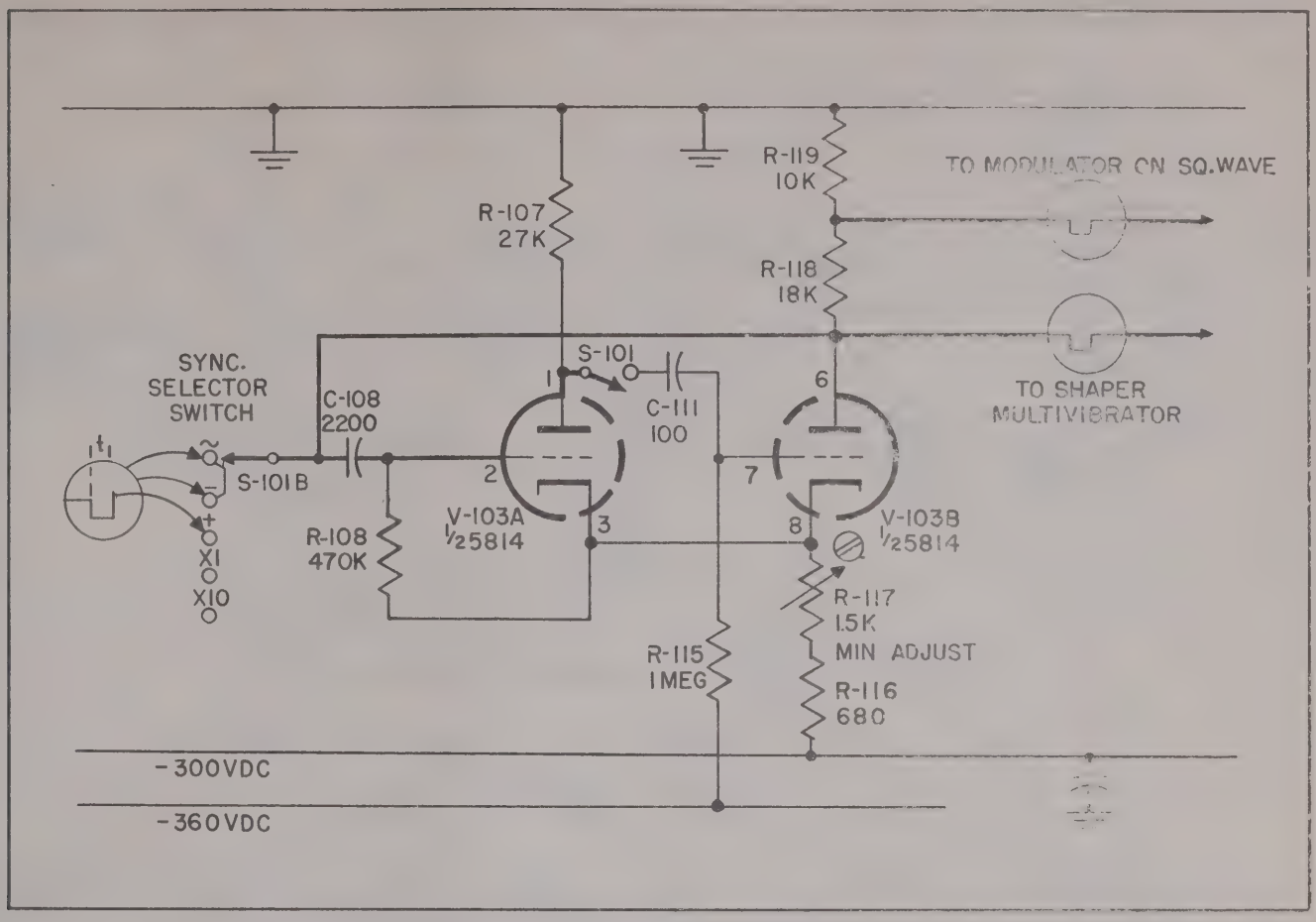


Figure 4-18. Simplified Schematic of Basic PULSE RATE Multivibrator, External Sync Condition

in figure 4-17. V-101A is 1/2 of a type 12AT7 dual triode. The grid is returned to ground, the cathode to the -300 vdc line. This places the grid at zero bias and the tube is drawing current through plate load resistor R-103. The tube responds to both positive and negative signals.

4-56. OPERATION WITH NEGATIVE SYNC. IN VOLTAGE. The negative-going portion of a sine wave synchronizing voltage, or a negative sync pulse, causes the tube to cut off, developing a positive pulse in its plate circuit. This is applied to the grid of V-101B. V-101B is normally cut off with a bias of -15 volts, and the applied positive voltage causes it to draw current through load resistor R-105, developing a negative square wave with a steep leading edge. This negative pulse is applied to the ~ and - contacts of the SYNC. SELECTOR switch S-101A through the series diode clipper V-102A. V-102A acts to apply only negative voltages to the following circuits.

4-57. OPERATION WITH POSITIVE SYNC. IN VOLTAGE. When a positive external sync voltage is applied to the grid of V-101A, a negative voltage is developed in its plate circuit and applied to the + contact of S-101A by capacitor C-103.

4-58. PULSE RATE MULTIVIBRATOR EXTERNAL SYNC CONDITION. When external sync signals are employed, the PULSE RATE multivibrator is switched out of operation as shown in figure 4-18. The negative pulse from diode V-102A is switched around the rate multivibrator directly to differentiating capacitor C-112 and shaping multivibrator V-105.

4-59. PULSE RATE MULTIVIBRATOR, FREE-RUNNING CONDITION. When the SYNC SELECTOR switch, S-101, is in the X1 or X10, or SQ. WAVE positions, the PULSE RATE multivibrator is converted to a free-running condition (figure 4-19). Under this condition the sync input circuits are disconnected from the PULSE RATE multivibrator. The time constants of the multivibrator are balanced so that the circuit generates a voltage wave that is essentially square (50% duty cycle at 1,000 pps). This arrangement is used so that internal square wave as well as internal pulse modulation of the r-f oscillator can be obtained. The arrangement also provides equally spaced pulses to trigger the sawtooth generator when internal sawtooth frequency modulation is desired.

4-60. OUTPUT OF PULSE RATE MULTIVIBRATOR. A square wave of full amplitude is taken from the plate of V-103B across both R-118 and R-119 and applied to the SYNC. OUT pulse shaping multivibrator. The voltage developed across R-119, approximately one-third the full amplitude, is fed to the modulator when the MOD. SELECTOR switch is in the SQ. WAVE position. This output to the modulator is employed only when square wave modulation is desired.

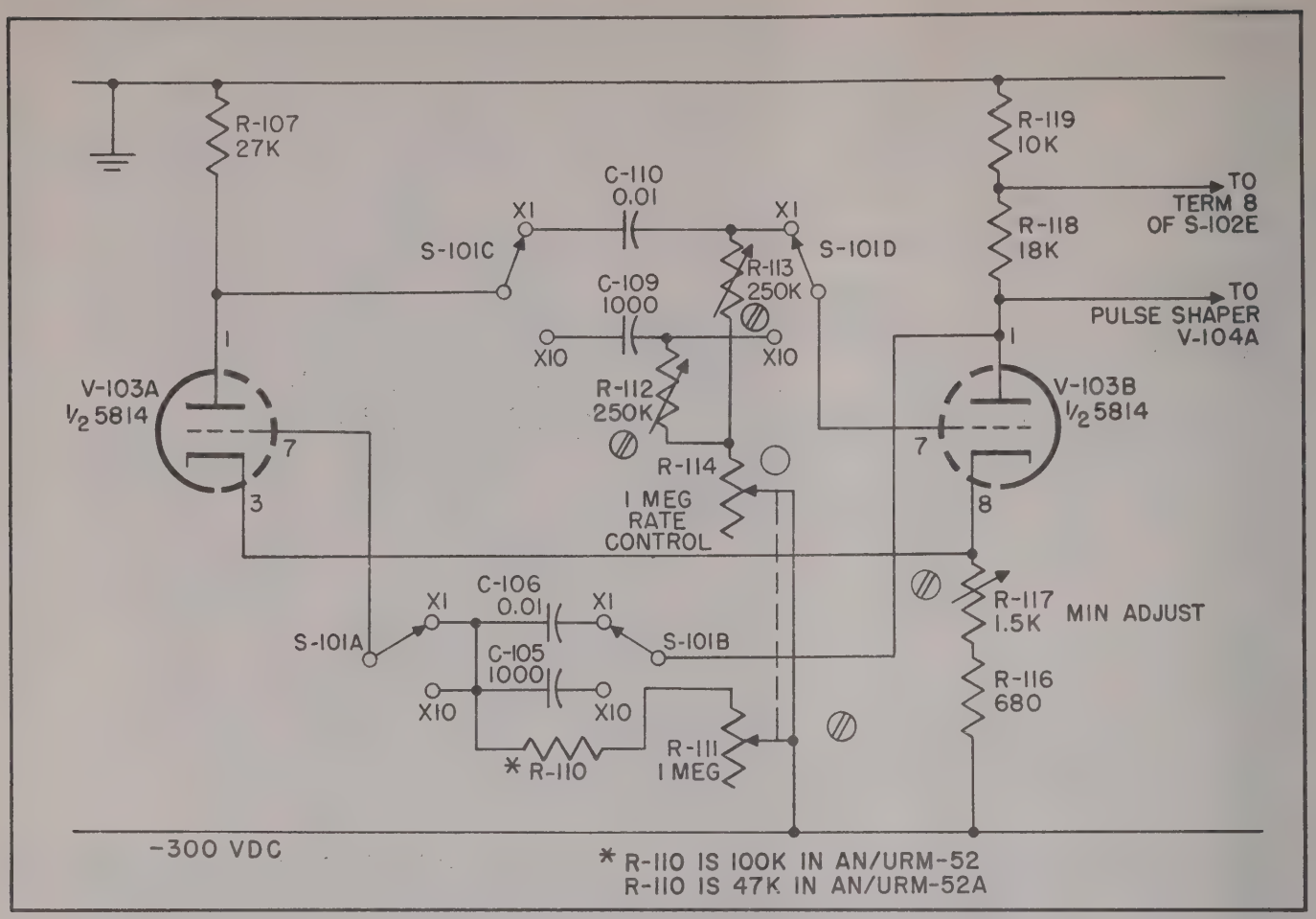


Figure 4-19. Simplified Schematic of Basic PULSE RATE Multivibrator, Free-Running Condition

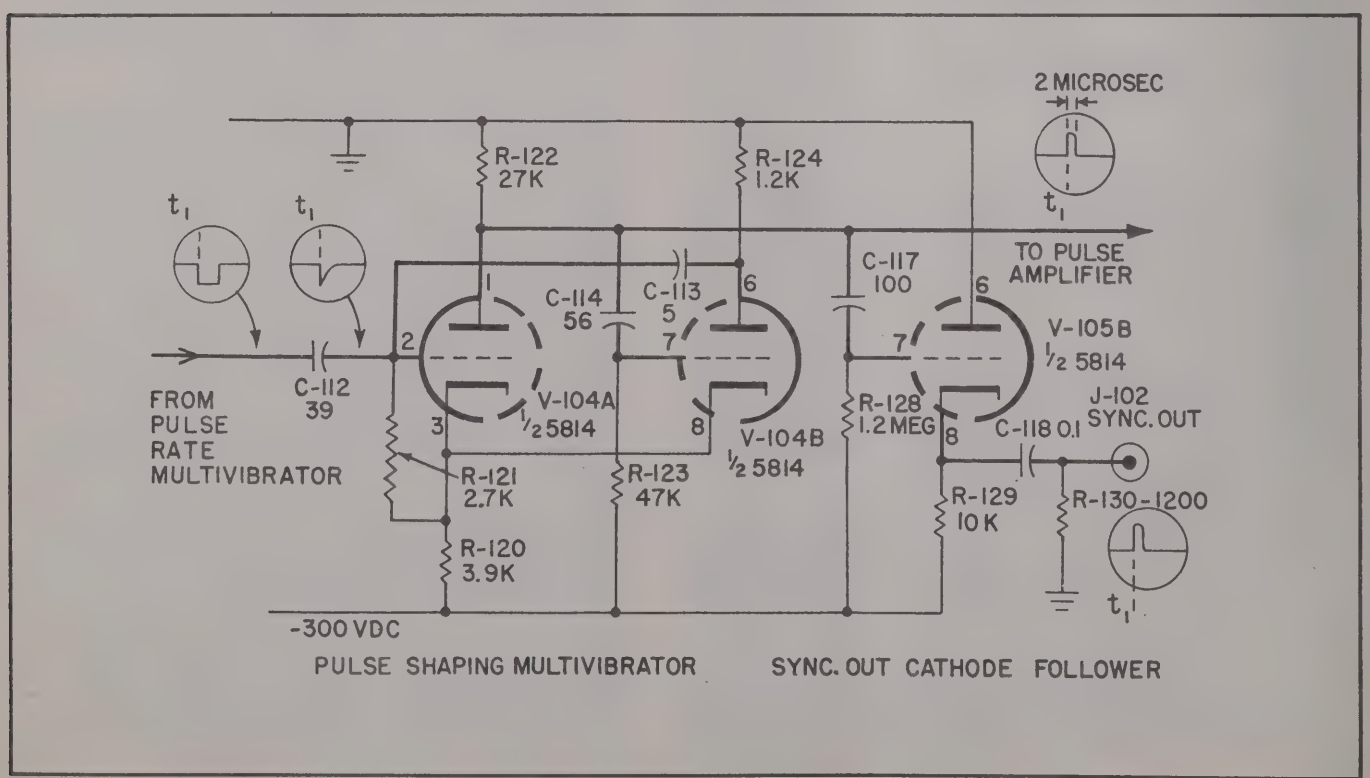


Figure 4-20. Simplified Schematic of Pulse Shaping Multivibrator and SYNC. OUT Cathode Follower

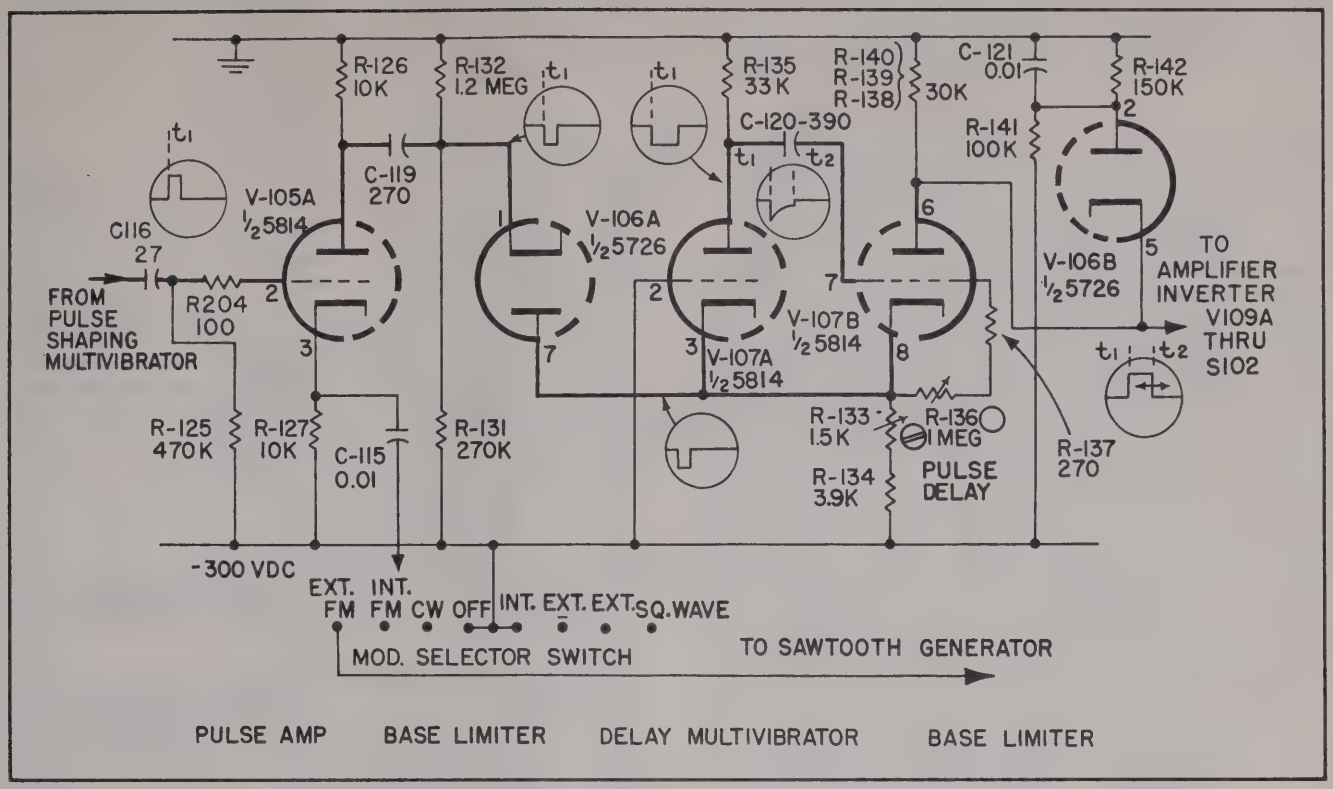


Figure 4-21. Simplified Schematic of Pulse Amplifier and PULSE DELAY Multivibrator

4-61. SYNC. OUT PULSE SHAPING MULTIVIBRATOR. The SYNC. OUT pulse shaping multivibrator (figure 4-20) is a one-cycle multivibrator with a two-microsecond time constant. It consists of V-104A and V-104B, two halves of a type 5814 dual triode. In the steady state condition V-104A is drawing current as its grid is returned to the cathode by resistor R-121. V-104B is cut off as its grid is returned to -300 vdc, thus placing a bias on the grid developed by the flow of current through V-104A and cathode resistor R-120. When this multivibrator is triggered by the negative-going leading edge of the voltage generated by the pulse rate multivibrator, a positive voltage pulse appears at its plate, since current flow through R-122 stops as the tube cuts off. The width of this positive pulse is determined by the time necessary to discharge C-114 through R-123. At this point the circuit returns to its resting condition, terminating the pulse. The pulse width is narrow, essentially two microseconds.

4-62. SYNC. OUT CATHODE FOLLOWER. The positive output pulse developed by V-104 is applied to the pulse amplifier tube V-105A shown in figure 4-21 and to the SYNC. OUT cathode follower, V-105B, shown in figure 4-20. V-105B provides the undelayed sync output signal for synchronizing external equipment. It is a standard cathode follower comprised of V-105B, one-half of a type 5814 dual triode tube. The output is taken across R-129, the cathode resistor, and is capacitively coupled to the SYNC. OUT connector, J-102, by C-118. Resistor R-130 is returned from the center conductor of the connector to ground so that the line is terminated with reference to ground instead of the -300 vdc potential existing at the base of the cathode resistor. The output of the cathode follower is a positive pulse greater than 25 volts when applied to a load having a resistance of from 1000 to 100,000 ohms and a shunt capacitance not greater than 500 mmf. At no load, the pulse will have an amplitude up to 55 volts.

4-63. PULSE AMPLIFIER. The pulse amplifier is comprised of V-105A, one half of a type 5814 tube, as shown in figure 4-21, and its associated circuit elements. It amplifies and inverts the two-microsecond pulse provided by the pulse shaping multivibrator and provides a negative pulse at t_1 in its plate circuit. It also provides a positive-going pulse in its cathode circuit from C-115 that is employed to trigger the sawtooth generator when internal frequency modulation is employed. C-115 is connected as a cathode bypass capacitor when internal pulse modulation is employed.

4-64. PULSE DELAY MULTIVIBRATOR CLAMP. The negative pulse from the plate of the pulse amplifier is applied to the cathode of the diode limiter V-106A shown in figure 4-21. This limiter is connected so that only the negative pulse components with an amplitude greater than the bias on the diode will pass on to the cathode of the PULSE DELAY multivibrator. This prevents triggering of the multivibrator by any positive or low amplitude negative transients that may appear on the output of V-105A in addition to the desired trigger pulse.

4-65. PULSE DELAY MULTIVIBRATOR. This circuit (figure 4-21) provides an adjustable time delay in applying the modulation to the r-f oscillator. It consists of the two sections of V-107, a type 5814 dual triode connected as a one-cycle multivibrator with a time constant adjustable from 3 to 300 microseconds. In the steady state condition V-107A is cut off while V-107B

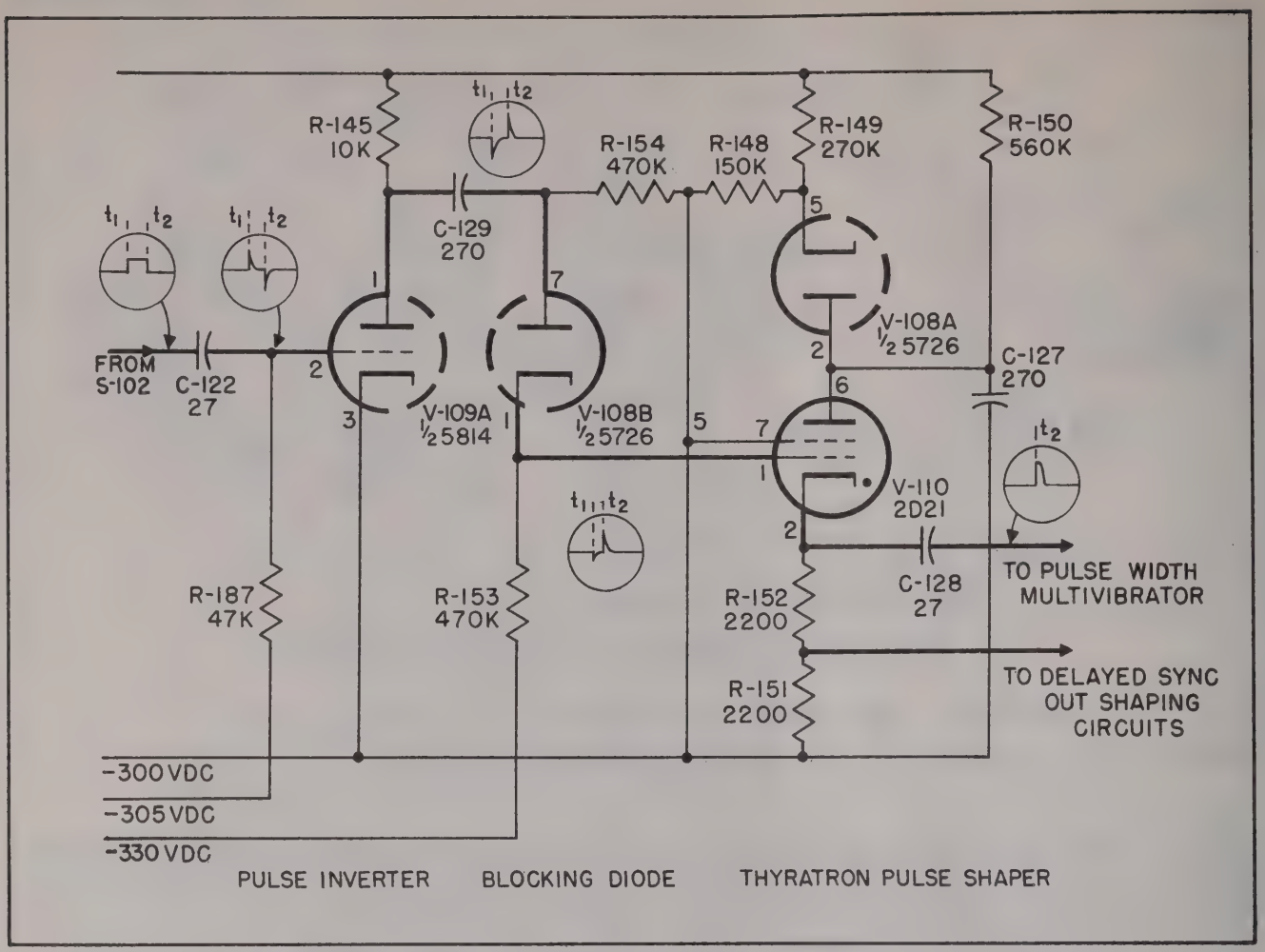


Figure 4-22. Simplified Schematic of Thyratron Pulse Shaper Circuits

is drawing current through its plate load resistors R-138, R-139 and R-140 in parallel with R-142 and the diode V-106B. The multivibrator starts its cycle when a negative pulse drives the cathode of V-107A in a negative direction. This is equivalent to placing a positive signal on the grid, and the tube draws current. A negative wave front of voltage appears at the plate of V-107A and through capacitor C-120 drives the grid of V-107B in a negative direction, cutting off this half of the stage. The length of time the circuit will require before returning to its resting condition will be determined by the time constant of C-120, R-133, R-134, R-136 and R-137. R-136 is the calibrated PULSE DELAY control that adjusts the delay from 3 to 300 microseconds, while R-133 is an internal adjustment used to set the maximum delay to 300 microseconds (see paragraph 6-34).

4-66. PULSE DELAY MULTIVIBRATOR NEGATIVE BASE LIMITER. V-106B serves an additional function during the resting condition by acting as a negative base limiter. It does this by preventing low amplitude negative pulses that may otherwise follow the trailing edge of the main pulse from V-107B.

4-67. PULSE AMPLIFIER-INVERTER. This stage, shown in figure 4-22, is comprised of V-109A, one half of a type 5814 dual triode. The positive square wave voltage from the PULSE DELAY multivibrator is differentiated by capacitor C-122 and resistor R-187 to form a sharp positive voltage spike at t_1. These are amplified, and arrive inverted in the plate circuit of V-109A.

4-68. BLOCKING DIODE. The output of V-109A is applied to the grid of the thyratron pulse shaper V-110 through blocking doide V-108B. The purpose of V-108B is to pass the positive output voltage spike at t_2 from V-109A and to block the negative spike at t_1. At short delays this insures positive triggering action of the thyratron V-110.

4-69. THYRATRON PULSE SHAPER. This stage consists of the type 2D21 thyratron tube V-110, shown in figure 4-22. Its grid is returned to approximately -330 volts while the cathode is returned to -300 volts, cutting off the tube. Capacitor C-127 is charged to approximately 110 volts positive to the cathode, a voltage established by the values of R-148 and R-149 and diode V-108A. This device for limiting the voltage on C-127 is necessary due to wide variation in the pulse repetition frequency of the unit and the fact that the capacitor will charge exponentially with time. This would result in the capacitor charging to a higher potential at the low repetition frequencies than at the higher frequencies.

The diode circuit limits the charge to a value that can be reached at the highest repetition frequencies, and prevents it from becoming higher regardless of the charging time available.

4-70. TRIGGER ACTION OF THYRATRON PULSE SHAPER. When the positive pulse from V-109A reaches the grid, the gas in the tube ionizes and C-127 discharges through the tube, and cathode resistors R-151 and R-152 in series. This causes a positive pulse to appear across the cathode resistors. When C-127 is nearly discharged and the plate voltage is at a very low value the gas in the tube deionizes and the tube returns to the resting condition. By this time the pulse on the grid has decayed and the grid bias is again -330 volts. C-127 is rapidly recharged to its resting voltage of approximately 110 volts and is maintained at this value through the action of the diode circuit explained above.

4-71. OUTPUT OF THYRATRON PULSE SHAPER. Two positive voltage spikes occurring at t_2 are taken from the cathode circuit. One of these is supplied to the PULSE WIDTH multivibrator, while the other is supplied to the delayed sync pulse output circuits.

4-72. PULSE WIDTH MULTIVIBRATOR. The PULSE WIDTH multivibrator shown in figure 4-23 is a one-cycle multivibrator employing a type 5814 tube V-111. The circuit employs capacitive cathode to cathode coupling to secure the necessary interstage action. This avoids any feed-back connection to the plate of V-111A, reducing stray capacitance that would tend to slow down the voltage rise and fall. Peaking inductance L-101 is also employed in the plate circuit from which the output is taken to further steepen the wave front. The section comprised of V-111A is cut off since a negative bias of 30 volts is placed on its grid. This places the V-111A side of C-130 at a potential of -300 volts. The second section is drawing saturation current since its grid is maintained at essentially the cathode voltage by

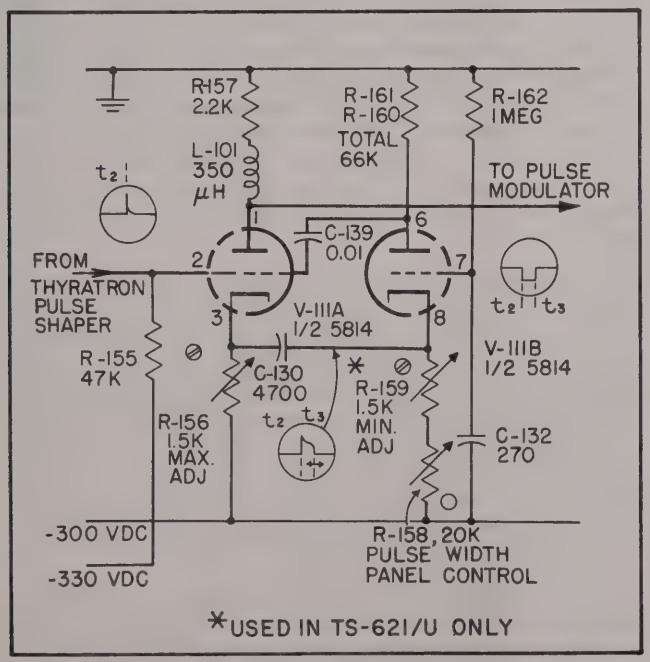


Figure 4-23. Simplified Schematic of PULSE WIDTH Multivibrator

R-162. As a result, the other side of C-130 is at a relatively higher potential due to the drop across R-157 and R-158.

4-73. TRIGGER ACTION OF PULSE WIDTH MULTIVIBRATOR. When the positive pulse at t_2 is applied to the grid of V-111A, it immediately draws current, causing the V-111A side of C-130 to rise instantly an amount equivalent to the potential set up by the current flowing through R-156. R-156 is adjustable, and the amount of this rise is determined by the resistance in circuit. R-156 acts as a maximum pulse width adjustment for the circuit. The voltage rise across R-156 is applied to the cathode of V-111B causing it to become more positive with respect to grid pin 7. This cuts off the tube rapidly since the grid is maintained at essentially the cathode potential due to the time constant of R-162 and C-132. Capacitor C-130 is now charged in a positive direction and commences to discharge through R-157 and R-158. The time constant of this discharge to the point where V-111B will again draw current determines the duration of the negative output pulse taken from the stage. In the AN/URM-52, the minimum width controlled is adjusted by R-159, a screwdriver adjustment on the chassis, while the actual pulse width is adjusted by R-158, the calibrated PULSE WIDTH control on the panel. In the AN/URM-52A, pulse width is adjusted only by PULSE WIDTH control R-158. This control can be adjusted to provide pulses of from 0.5, to 10 microseconds duration.

4-74. OUTPUT OF PULSE WIDTH MULTIVIBRATOR. The output of the PULSE WIDTH multivibrator is a negative pulse starting at t_2 and ending at t_3. This negative pulse is applied to the pulse modulator tube V-113.

4-75. PULSE MODULATOR. The pulse modulator circuits shown in figures 4-24 and 4-24A are comprised of V-113, a type 5763 pentode amplifier and V-112A, one half of a type 12AT7 dual triode connected as a diode positive peak clipper on its input grid. V-112B, the other half of the type 12AT7 dual triode, diode-connected, provides a fixed operating bias for the modulator grid of the klystron r-f oscillator tube V-114. The positive pulse from the PULSE WIDTH multivibrator is coupled to the control grid of V-113 by C-133 and C-134 in parallel. Bias for the grid is adjusted by potentiometer R-338 in the power supply so that the flow of current in the modulator is sufficient to cut off the klystron. In the AN/URM-52, R-341 (figure 4-24) provides adjustment of the cathode-plate potential applied to diode-connected tube V112B. In the AN/URM-52A, this adjustment is provided by the combination of R-341 and R-352 (figure 4-24A). Tube V-112B functions as a positive clamp in the output circuit of pulse modulator tube V-114, which is also the control grid circuit of the klystron oscillator, V-114. The positive excursion of the modulating pulse is clamped at a value determined by the cathode-plate potential applied to tube V-112B. In this way, the klystron beam current is maintained at an average value suitable for the modulation duty cycle. The modulation duty cycle during FM, or during continuous output is greater than that for pulse or square wave modulation. The operating characteristics of the klystron, when pulse modulated, improve with increased beam current. In the AN/URM-52A, R-352 is provided for adjusting the beam current. R-352 is connected only when MOD SELECTOR switch

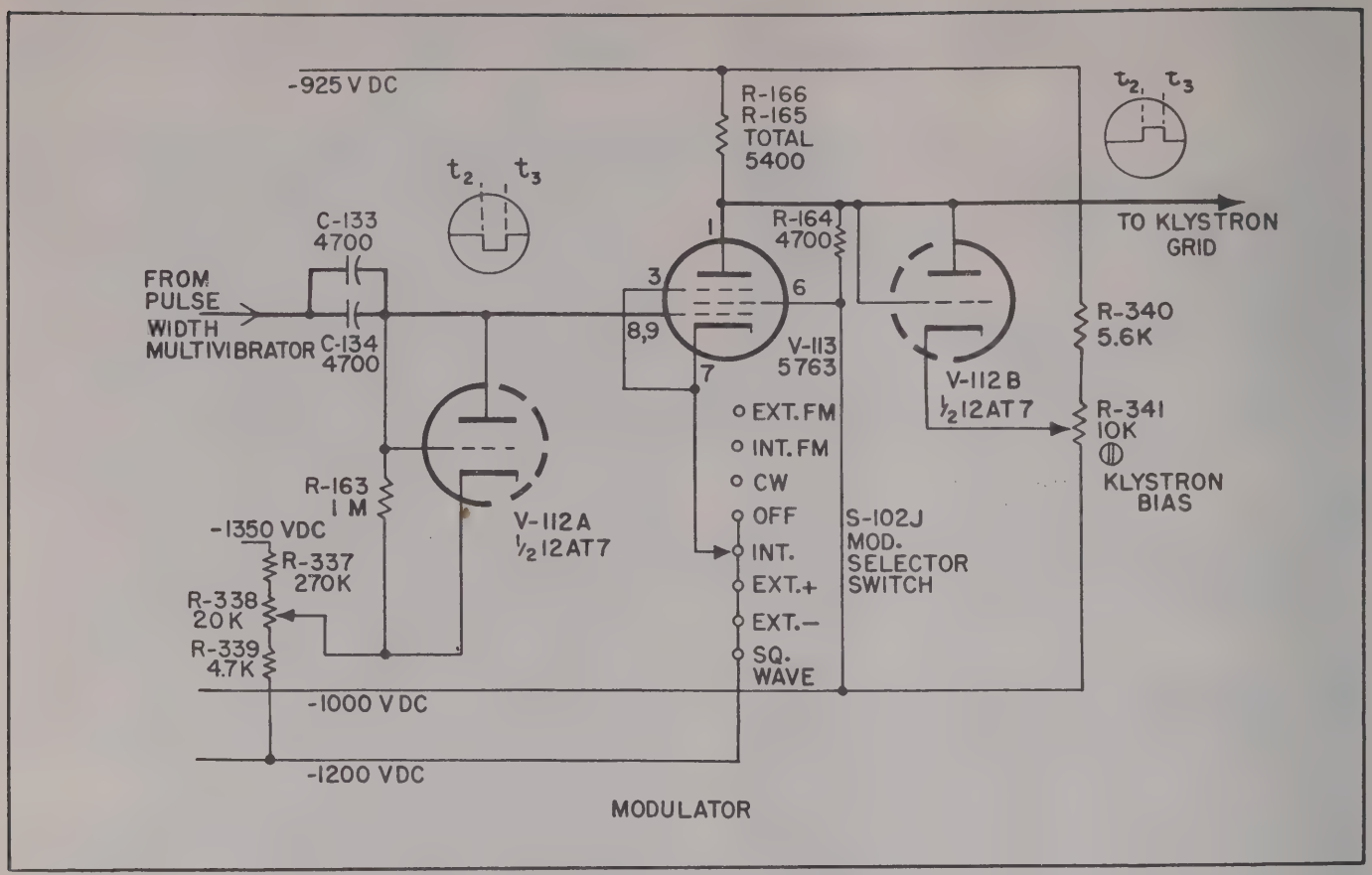


Figure 4-24. Simplified Schematic of Klystron Modulator Circuit, AN/URM-52

S-102J is positioned at INT, EXT+, EXT-, or SQ WAVE. Under these modulation conditions, R-352 enables adjustment of klystron beam current independently from that resulting from adjusting R-341 for MOD SELECTOR switch positions CW, INT, FM, or EXT FM.

4-76. MODULATING ACTION. When the negative pulse of voltage starting at t_2 and terminating at t_3 appears on the control grid of V-113, the grid is driven to cutoff. The voltage at the plate tends to rise instantly to approximately 965 volts since current flow through its plate resistors is cut off. However, when it crosses the voltage value established by the setting of R-341, the diode plate becomes positive with respect to the cathode. Current will then flow through the diode, limiting the positive excursion of the voltage at the grid of the klystron tube to the bias established by the setting of R-341. At the termination of the negative pulse at t_3 the voltage at the grid of V-113 rises instantly, permitting the tube to again draw current. Any positive transient existing at t_3 will be clipped by diode V-112A. At the same time (t_3) the voltage at the plate of V-113 will drop, since it will start drawing plate current through its plate resistors. Flow of current through V-112B will be blocked at the instant the plate voltage drops below the point established by the adjustment of R-341, and the voltage applied to the grid of the klystron will cut off oscillations in the r-f oscillator. The modulator tube, in the manner just described, provides an optimum positive output to the modulator grid of the r-f oscillator tube to permit it to oscillate during the period between t_2 and t_3.

4-77. DELAYED SYNC. OUT PULSE SHAPING MULTIVIBRATOR. (See figure 4-25.) The DELAYED SYNC. OUT pulse shaping multivibrator is comprised of the two triode sections of the type 5814 tube V-115. The positive voltage spike developed in the cathode circuit of the thyratron discharge tube is applied to the grid of V-115A through capacitor C-138 at time t_2. The section of the multivibrator formed by V-115A is cut off, its negative bias being established by current of V-115B flowing through cathode resistor R-195. The section comprised of V-115B is drawing current in the resting condition as its grid is returned to the cathode through R-194.

4-78. TRIGGER ACTION OF V-115 STAGE. The positive leading edge of the pulse from V-110 causes the multivibrator to switch cutting off current through V-115B and causing the voltage at its plate to rise. The time constant of the circuit is approximately two microseconds. At the end of this time capacitor C-139 is charged through R-194 and R-195 to a point where V-115B again draws current and completes the cycle. The output at the plate of V-115B is a positive voltage pulse of two microseconds duration. This is coupled to V-109B, the cathode follower.

4-79. DELAYED SYNC. OUT CATHODE FOLLOWER. V-109B is a conventional cathode follower employed as an impedance transformer, receiving the pulse from the high impedance plate of the multivibrator and delivering it to the relatively low impedance across the DELAYED SYNC. OUT connector, J-104 located on the panel, for synchronizing external equipment at t_2.

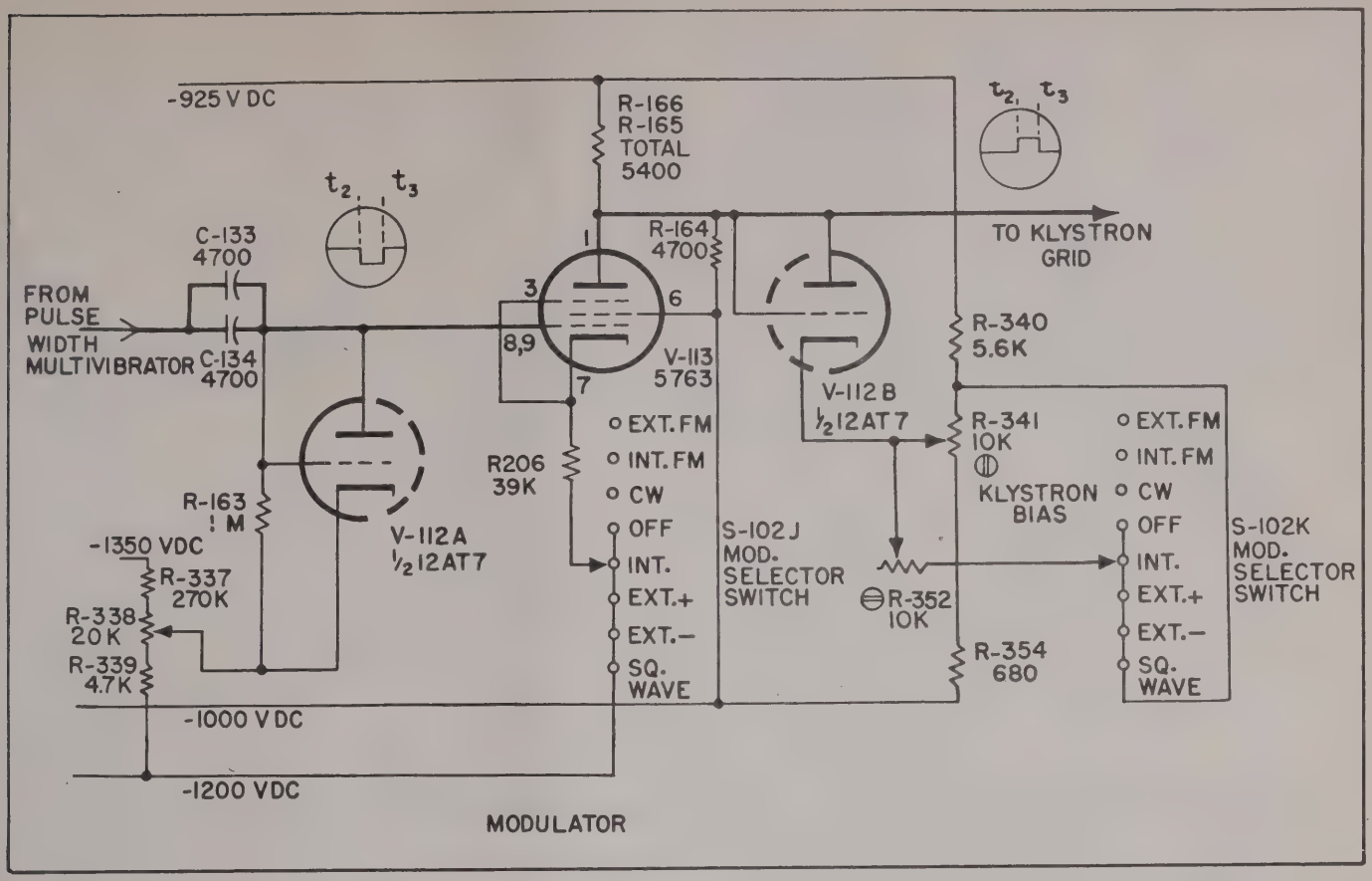


Figure 4-24A. Simplified Schematic of Klystron Modulator Circuit, AN/URM-52A

4-80. INTERNAL FREQUENCY MODULATION. When the MOD. SELECTOR switch S-102 is in the INT. FM position, the thyratron pulse shaper V-110, is switched to form a conventional relaxation oscillator as shown in figure 4-26. This oscillator develops a sawtooth voltage wave that is applied to the r-f oscillator repeller. C-124, C-125 and C-126 with resistors R-146 and R-147 determine the time constant of the sawtooth output for the X1 range while C-126, R-146 and R-147 perform the same function for the X10 range. R-147 is ganged with R-111 and R-114 and adjusted by the calibrated PULSE RATE control on the panel, so that the f-m sweep rate and the internal pulse repetition rate may be adjusted by the same control. The relaxation oscillator is triggered by a positive pulse from the cathode of the pulse shaper and, when activated, delivers a rising sawtooth voltage to the repeller, sweeping the frequency and providing sawtooth frequency modulation.

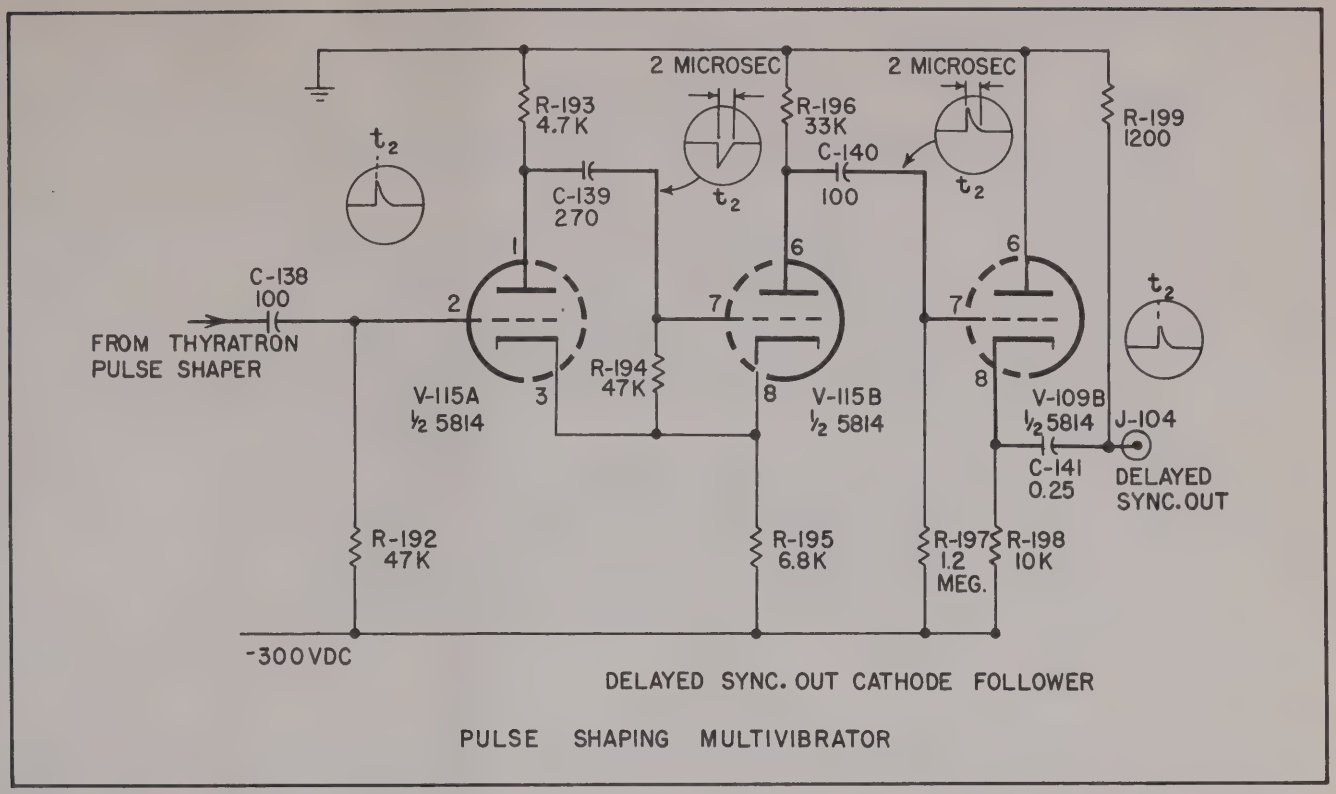


Figure 4-25. Simplified Schematic of DELAYED SYNC OUT Pulse Shaping Multivibrator and Cathode Follower

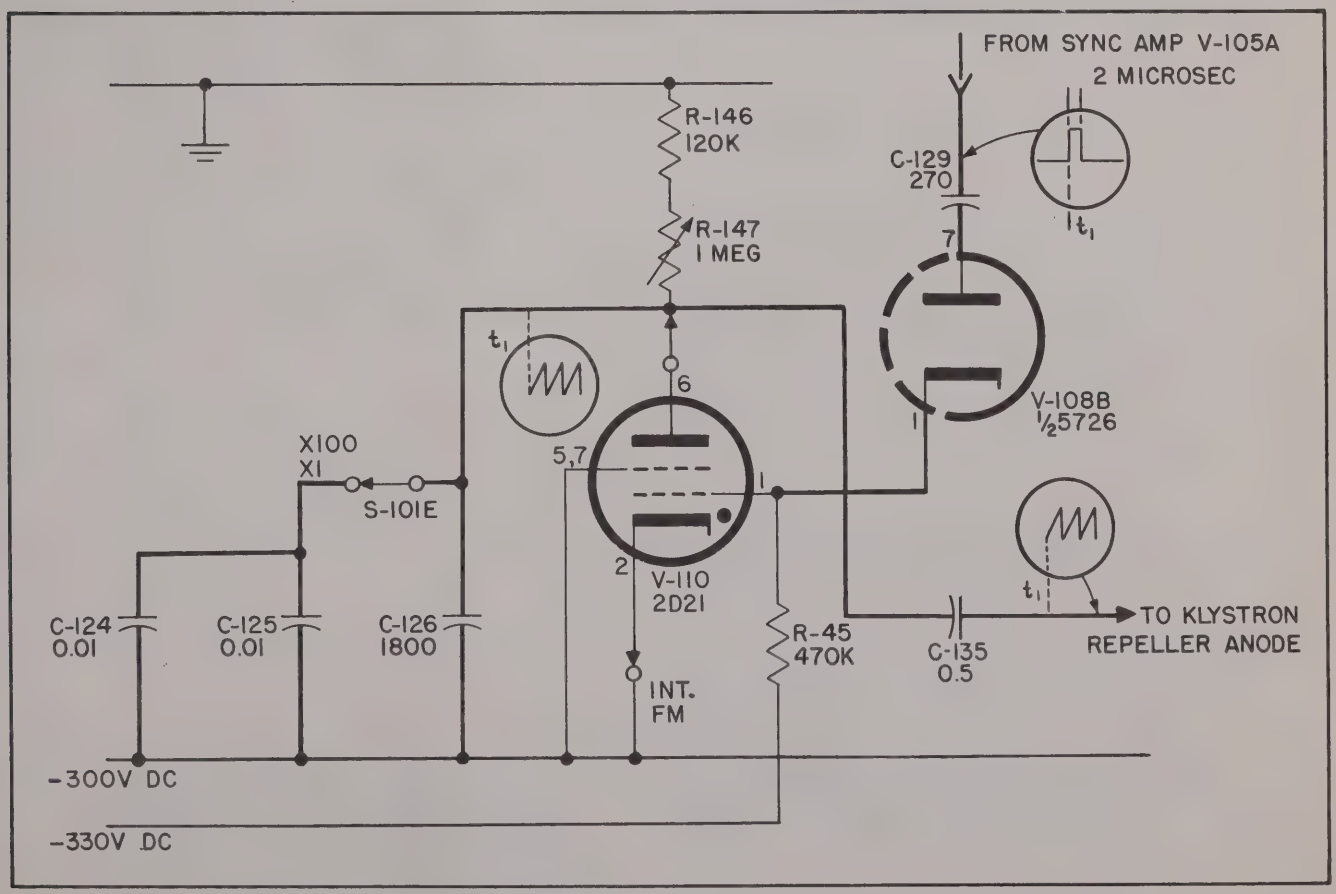


Figure 4-26. Simplified Schematic of Internal Frequency Modulation Circuits

SECTION V

ORGANIZATIONAL AND SQUADRON MAINTENANCE

5-1. MINIMUM PERFORMANCE STANDARDS.

5-2. GENERAL. The following check charts are tabular forms of indications, readings, and tests. They serve as minimum standards of performance for the equipment. The POWER SET meter (figures 1-2 and 1-2A) on the front panel of the instrument will serve as an indicator for this procedure.

5-3. OPERATIONAL CHECK CHART. It is assumed that the cables have been connected for inputs and outputs, the ON switch has been turned to ON, and that the controls have been set to the type of operation desired. It is further assumed that an oscilloscope having an accurately calibrated sweep control is available.

OPERATIONAL CHECK CHART

Step	Control Positions	Check
1.	Turn ON switch to ON.	POWER indicator lights, blower starts and HEATER indicator is extinguished.
2.	Turn SIGNAL FREQUENCY control to desired frequency. If used, external synchronization or modulation equipment should be turned on.	
3.	Set MOD. SELECTOR switch to OFF.	
4.	After approximately 30 seconds, adjust ZERO SET control.	POWER SET meter needle is exactly over ZERO SET line on meter.
5.	Set MOD. SELECTOR switch to CW.	POWER SET/DBM meter needle should deflect from ZERO SET position after approx. two minutes.
6.	Adjust POWER SET control for 0 DBM.	POWER SET meter indicates 0 DBM (red line at center of scale).
7.	Set MOD. SELECTOR switch to position for type of operation desired.	
8.	Adjust OUTPUT ATTEN. control for desired output.	Observe operation of Signal generator with auxiliary equipment if available, and note any malfunction.
9.	MOD. SELECTOR switch to SQ. WAVE	Instrument operates on SQ. WAVE. POWER SET meter indication will change to between -2 and -4 DBM.
10.	Set SYNC. SELECTOR switch to X10. Set MOD. SELECTOR switch to INT. Set PULSE RATE and PULSE WIDTH controls to extreme clockwise position. Adjust POWER SET control for maximum reading on POWER SET meter. Vary PULSE RATE and PULSE WIDTH controls.	POWER SET meter indication will change with variation of PULSE RATE and PULSE WIDTH controls, indicating effectiveness of these controls.

OPERATIONAL CHECK CHART (Cont)

Step	Control Positions	Check
11.	Set MOD. SELECTOR switch to EXT. +. Connect video cord from SYNC. OUT connector to EXT. MOD. connector. Set PULSE RATE control to extreme clockwise position. Adjust POWER SET control for maximum reading on POWER SET meter. Vary PULSE RATE control.	Power set meter indication will vary just slightly above ZERO SET with variation of PULSE RATE control, indicating operation on EXT. MOD. position with positive external pulses, and existence of SYNC. OUT pulse.
12.	Set MOD. SELECTOR switch to INT. FM. Set SYNC. SELECTOR switch to X10, PULSE RATE control to 400. Increase FM AMPLITUDE control from OFF to maximum clockwise position.	POWER SET meter reading will decrease as control is rotated beyond approx. mid-position, proving existence of frequency modulation.

5-4. SYSTEM ANALYSIS.

5-5. This section contains trouble-shooting data and step-by-step procedures necessary to determine which function or major section of the equipment, as shown in the block diagrams figures 4-1 and 4-16, is causing the malfunction or failures. Section VI continues the analysis in greater detail and carries it down to the faulty parts. Because the signal generator is itself used in servicing or testing other equipment, the personnel operating the signal generator must be qualified maintenance personnel. For the reasons given above, reference has been made in this section to Section VI for the more complete and detailed procedures.

5-6. EQUIPMENT FAILURE. (For a more detailed trouble-shooting procedure see paragraph 6-20.) The first step in correcting any trouble or failure which may occur in the instrument is to isolate the section of the circuit which is causing the trouble. To isolate a defective part or determine the cause of equipment failure will require a complete understanding of the equipment's function. The existence of a malfunction will become apparent in one or more steps of the procedure given in paragraph 5-3 and a thorough study of the block diagrams, figures 4-1 and 4-16, will aid materially in isolating the source of the malfunction. The schematic diagrams, figures 7-1, 7-1A, 7-2 and 7-2A, and the voltage and resistance diagrams, figures 7-4 and 7-5, should be consulted. It should be kept in mind that the source of the trouble ordinarily lies in only one section at a time, however because of interdependence of the various circuits, symptoms may appear throughout the system.

5-7. SIGNAL TRACING. For assistance in signal tracing through the circuits of the pulser section a table of oscillograms is included in section VI. This method of trouble shooting requires the use of a high speed synchroscope and a technician experienced in the reading of waveform pictures.

5-8. TROUBLE-SHOOTING CHART. As a further aid in isolating the section causing the trouble in the instrument, refer to the following trouble-shooting chart. Unless otherwise specifically stated in the chart, the controls should be adjusted as follows, after the initial warm-up procedure given in paragraph 5-3, steps 1 through 6. Refer to paragraph 5-9 for summary of symptoms and possible causes of malfunctions.

CONTROL SETTINGS FOR TROUBLE-SHOOTING

CONTROL	SETTING
MOD. SELECTOR switch	INT.
SYNC. SELECTOR switch	X10
PULSE RATE control	100
PULSE DELAY control	Extreme counter-clockwise position
PULSE WIDTH control	10
SIGNAL FREQUENCY control	Any desired frequency
OUTPUT ATTEN. control	0 dbm.

TROUBLE-SHOOTING CHART

Step	Test Point	Control Positions	Test Procedure	Normal Indication
1.		Initial settings, control setting chart, paragraph 5-8	Connect oscilloscope vertical input to SYNC. OUT connector. Set sweep of oscilloscope so that at least two pulses appear on screen.	SYNC. OUT pulses should appear on oscilloscope at periods of approx. 1000 microseconds, should be steady with a clear trace.

Step	Test Point	Control Positions	Test Procedure	Normal Indication
2.		Vary setting of PULSE RATE control above and below 100.	Same as step 1.	Pulses should move closer together and farther apart, indicating effectiveness of PULSE RATE control in X10 pos. of SYNC. SELECTOR switch.
3.	Same as step 1.	Set SYNC. SELECTOR switch to X1, and repeat steps 1 and 2.	Same as step 1.	SYNC. OUT pulses should now have a period of approx. 10,000 microseconds, indicating effectiveness of PULSE RATE control in X1 position of SYNC. SELECTOR switch.
4.		Initial settings. Vary setting of PULSE DELAY control	Connect oscilloscope vertical input to DELAYED SYNC. OUT connector. Connect oscilloscope TRIGGER INPUT to SYNC OUT connector.	Pulse, or evenly spaced pulses, should move across the screen with variation of PULSE DELAY control, indicating effectiveness of the control.

5-9. SUMMARY OF SYMPTOMS AND POSSIBLE CAUSES. Each of the steps outlined in the Operational Check Chart, paragraph 5-3, and the Trouble Shooting Chart, paragraph 5-8, checks essentially only one function at a time. Since a given source of trouble may affect several functions of the equipment simultaneously, it will take a number of steps to isolate the source of trouble. The following table is designed to aid in such isolation. The symptoms are those which have been observed in the chart, or charts, in paragraph 5-3 and/or 5-8, in addition to any which were observed when the instrument was being used.

SUMMARY OF SYMPTOMS AND POSSIBLE CAUSES OF MALFUNCTION

SYMPTOM	POSSIBLE CAUSE	REMEDY
1. Instrument dead; neither indicator lights; no output.	Blown fuse F-301 and/or F-302.	Check and replace fuses. Persistent failure of fuses indicates trouble within the instrument which must be corrected before normal operation may be resumed.
	Poor connection to, or failure of, primary source of alternating current.	Check power connection.
2. With the MOD. SELECTOR switch in the CW position and POWER SET control adjusted for normal reading, POWER SET meter fails to change from ZERO SET two minutes after power is applied.	Relay K-301 inoperative.	Check operation of relay K-301 by checking if heater of V-305 lights approx. two minutes after power is applied to the instrument. Replace relay K-301 if necessary.
3. Does not sync with external voltages; internal sync satisfactory	Defective circuit elements in SYNC. IN amplifier, V-101 stage.	Check and if necessary replace tube V-101 and associated circuit elements; check external connections to SYNC. IN connector J-101.

SUMMARY OF SYMPTOMS AND POSSIBLE CAUSES OF MALFUNCTION (Cont)

SYMPTOM	POSSIBLE CAUSE	REMEDY
4. No SYNC. OUT pulse DELAYED SYNC. OUT and RF OUTPUT pulse satisfactory.	Defective circuit elements in SYNC. OUT cathode follower V-105-B.	Check and if necessary replace tube V-105 and associated circuit elements.
5. No DELAYED SYNC. OUT pulse; SYNC. OUT pulse and RF OUTPUT pulse satisfactory.	Defective circuit elements in V-115 stage or V-109-B stage.	Check and if necessary replace V-115 tube and/or tube V-109-B and associated circuit elements.
6. Poor or unstable performance in all positions of MOD. SELECTOR switch and SYNC. SELECTOR switch.	Defective circuit elements in power supply.	Check and if necessary replace tubes and circuit elements in power supply. (Readjust -300V DC regulated supply; see paragraph 5-18.)
7. No SYNC. OUT, DELAYED SYNC. OUT, or RF OUTPUT pulses; power supply operating properly.	Defective circuit elements in PULSE RATE and/or pulse forming multivibrators, V-103 and V-104.	Check and if necessary replace V-103 and/or V-104 and associated circuit elements.
8. R-F output continues when MOD. SELECTOR switches is on OFF.	Defective modulator tube, V-113, or improper setting of klystron bias adjustments.	Check and if necessary replace V-113. (See paragraph 5-16.)
9. Low, erratic, or no RF OUTPUT pulse; sync pulse output satisfactory.	Weak r-f oscillator, V-114, or improper settings of repeller tracking potentiometers or beam current control.	Check klystron beam current, and readjust if necessary. (See paragraphs 5-16 and 6-24.) If this does not clear the trouble, V-114 should be replaced. (See paragraphs 6-21, 6-22 and 6-23.)
10. No pulsed r-f output with MOD. SELECTOR switch on INT.	a. If pulsed r-f output is available with externally developed pulses but not from internally developed pulses, the modulator circuits and klystron, V-112 through V-114 may be considered operative and the fault lies in preceeding circuits.	Check and replace if necessary tubes preceding V-112 and V-114 and associated circuit elements.
	b. If a satisfactory SYNC. OUT pulse is not obtained when the MOD. SELECTOR switch is in the INT. position a fault lies in the circuits of V-103 through V-105. If this pulse is obtained, these circuits may be considered operative.	Check and if necessary replace tubes V-103 and V-105, and associated circuit elements.
	c. If a normal DELAYED SYNC. OUT pulse is not obtainable at the connector when a SYNC. OUT pulse is obtained, the fault lies in the circuits of V-106 through V-110 or V-115. If this pulse is present, these circuits may be considered operative.	Check and if necessary replace tubes V-106 through V-110 and V-115, and associated circuit elements.
	d. If no r-f pulse is obtained when the DELAYED SYNC. OUT pulse is satisfactory, the fault lies in the circuits of V-111 through V-114.	Check and if necessary replace tubes V-111 through V-114, and associated circuit elements. Check waveform at grid and plate of modulator tube V-113 to determine which of these four circuits and/or tubes is defective. (Refer to Section VI.)

SUMMARY OF SYMPTOMS AND POSSIBLE CAUSES OF MALFUNCTIONS (Cont)

SYMPTOM	POSSIBLE CAUSE	REMEDY
11. POWER LEVEL meter needle "pins" down scale regardless of switch positions.	Open thermistor R-202 in power monitoring probe, or thermistor R-201 mounting plate shorted to ground.	Check resistance of and if necessary replace probe, or check mounting for thermistor R-201.
12. POWER LEVEL meter needle "pins" up scale regardless of switch positions.	Shorted power monitoring probe.	Check resistance or probe and replace if necessary.
13. Poor decay time of r-f output pulse.	Open choke L-101.	Measure resistance of L-101, if above 10 ohms, replace.
14. Double r-f output pulse (normal pulse plus additional poorly shaped pulse).	Defective capacitor C-142 in pulser.	Check capacitor by substitution C-142 and replace if necessary.

5-10. TUBE FAILURE. If tubes are suspected to be the cause of a failure, the defective tube can usually be located by the following procedure:

a. The fit between the cabinet and instrument is intentionally tight, and removing the cabinet is a two-man job. With the line cord removed from the power source, remove the instrument from its cabinet by placing instrument face down on a low surface and loosening captive screws on the rear of the cabinet. The screws will not come out of the cabinet. Lift cabinet from instrument.

b. Plug the line cord into a power source, turn ON switch to ON, and allow the instrument to run for several minutes.

c. Turn ON switch to down, or off, position and carefully touch each tube. Any normal operating tube will feel warm or hot. A cold tube is a good indication of a failure. However, it is well to bear in mind that tubes frequently deteriorate in performance characteristics without completely failing. Such symptoms as low power output, erratic pulsing and synchronization, and generally poor performance can often be traced to changes in tube characteristics.

d. If a tube checker is available, subject each tube to a performance test, short test, and gas or leakage test. Replace any tube about which there is any doubt whatsoever as to its performance.

5-11. TUBE COMPLEMENT. The tubes used in the signal generator are described in the following table, and are shown located physically in figure 5-1. In the following table, replacement of those tubes without asterisks can be made without affecting the performance of the equipment. Replacing the tubes followed by asterisks (e.g. V-103*) requires that adjustments of internal controls be made to bring the overall operation and performance of the equipment up to standard. When these adjustments require special test equipment as well as more highly trained personnel, they are described in Section VI. The removal and replacement of V-114 as well as the adjustments required following such replacement are described in Section VI.

TABLE 5-1. TUBE COMPLEMENT

TUBE	JAN TYPE NUMBER		FUNCTION	REPLACEMENT ADJUSTMENT REFERENCES
	TS-621/U TS-621A/U	TS-621B/U		
V-101	12AT7	12AT7WA	SYNC. IN Amplifier and Inverter	None
V-102	5726	5726	Coupling Diode (1/2 tube not used)	None
V-103*	5814	5814	PULSE RATE Multivibrator	Par 6-33
V-104	5814	5814	SYNC. OUT Pulse Shaping Multivibrator	None
V-105	5814	5814	Pulse Amplifier and SYNC. OUT Cathode Follower	None
V-106	5726	5726	Base Limiter and Clamp for PULSE DELAY Multivibrator	None
V-107*	5814	5814	PULSE DELAY Multivibrator	Par 6-34
V-108	5726	5726	Clamp and Negative Pulse Clipper	None

TABLE 5-1. TUBE COMPLEMENT (cont)

TUBE	JAN TYPE NUMBER		FUNCTION	REPLACEMENT ADJUSTMENT REFERENCES
	TS-621/U TS-621A/U	TS-621B/U		
V-109	5814	5814	Pulse Amplifier-Inverter and DELAYED SYNC. OUT Cathode Follower	None
V-110	2D21	2D21	Thyratron Pulse Shaper	None
V-111*	5814	5814	PULSE WIDTH Multivibrator	Par 6-35
V-112*	12AT7	12AT7WA	Clipper and Klystron Grid Clamp	Par 5-16
V-113*	5763	5763	Modulator	Par 5-16
V-114*	6236	6236	Radio Frequency Oscillator	Par 6-21
V-115	5814	5814	DELAYED SYNC. OUT Multivibrator	None
V-301	5R4WGY	5R4WGB	Full Wave Rectifier	None
V-302*	6AU6	6AU6WA	Regulator Amplifier	Par 5-18
V-303*	6AS7	6080WA	Series Regulator	Par 5-18 and 5-19
V-304*	OA2	OA2WA	Voltage Regulator	Par 5-18
V-305	5R4WGY	5R4WGB	Full Wave Rectifier	None
V-306*	6AU6	6AU6WA	Regulator Amplifier	Par 5-19
V-307	5R4WGY	5R4WGB	Full Wave Rectifier	None
V-308*	6AS7	6080WA	Series Regulator	Par 5-20
V-309	6AU6	6AU6WA	Regulator Amplifier	Par 5-20
V-310*	OA2	OA2WA	Voltage Regulator	Par 5-20
V-311*	OA2	OA2WA	Voltage Regulator	Par 5-20
V-312*	OA3	OA3	Voltage Regulator	Par 5-20
V-313*	OA2	OA2WA	Voltage Regulator	Par 5-21
V-314*	OA2	OA2WA	Voltage Regulator	Par 5-21

5-12. TUBE REPLACEMENT AND NECESSARY ADJUSTMENTS

5-13. REPLACING V-103. Replacing V-103 may lessen the accuracy of the PULSE RATE control, but will not otherwise affect the performance of the signal generator. Refer to paragraph 6-33 for procedure for calibrating PULSE RATE control.

5-14. REPLACING V-107. Replacing V-107 may lessen the accuracy of the PULSE DELAY control. Refer to paragraph 6-34 for procedure for calibrating PULSE DELAY control.

5-15. REPLACING V-111. Replacing V-111 may lessen the accuracy of the PULSE WIDTH control, and it may not be possible to reach either the minimum or maximum pulse width indicated on the dial. Refer to paragraph 6-35 for calibration of PULSE WIDTH control.

5-16. REPLACING V-112 OR V-113. When either V-112 or V-113 is replaced it is necessary to check and/or adjust the klystron control grid cutoff voltage and beam current as soon as the instrument is turned on and the klystron is operating. This is done as follows:

a. Place MOD. SELECTOR switch to OFF.

b. Connect a d-c voltmeter with a sensitivity not less than 1000 ohms-per-volt between pin 3 of V-303 and the chassis, with the positive lead of the voltmeter on the chassis.

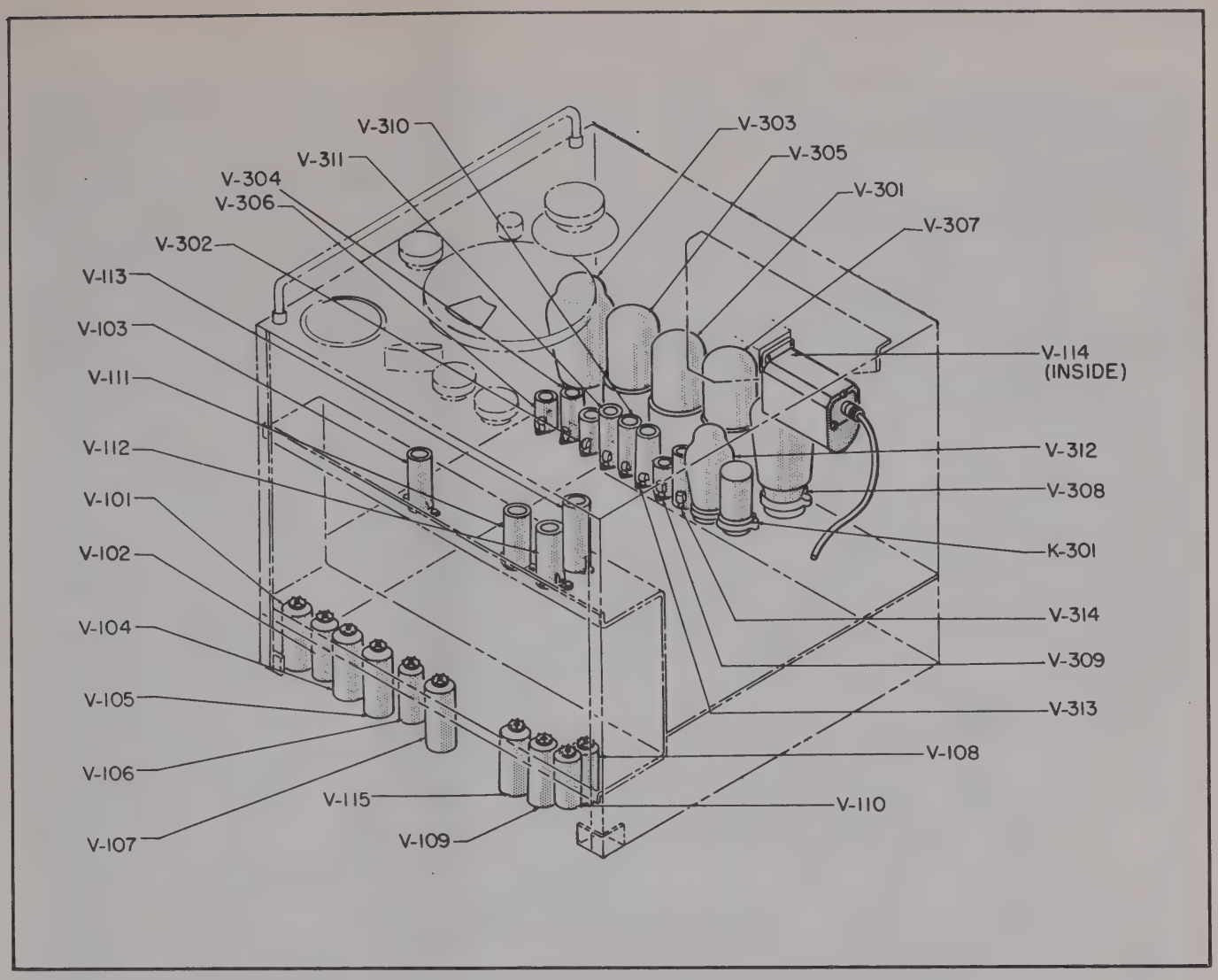


Figure 5-1. Location of Tubes

c. Adjust R-338 (figures 5-2 and 5-2A) until the voltage is a minimum (approximately 0.1 volt). It is recommended that the adjustment be made only to the point where the voltage no longer decreases. The remaining reading is the result of bleeder current not klystron anode current. To further the adjustment unnecessarily increases the plate current of the modulator tube V-113.

d. Place MOD. SELECTOR switch to CW.

e. Adjust R-341 (figures 5-2 and 5-2A) until the voltage is exactly 2 volts indicating a klystron anode current of 20 milliamperes. This value may be varied between 1.8 and 2.2 volts to give best operation of the klystron throughout the radio frequency range when pulse modulated.

5-17. REPLACING TUBES IN POWER SUPPLY. When replacing tubes in the power supply section of the signal generator, bear in mind that the three power supplies are all regulated and interdependent, each using another as a reference point, and that the positive sides of two of the supplies are at ground potential and that of the third is 925 volts negative to ground. A change in the output in the -300 volt supply in turn changes the output voltage of the -1000 volt supply. One half of V-303 is used in both the -300 and -1000 volt supplies; thus both supplies must be checked following its replacement.

5-18. REPLACING V-302, V-303 OR V-304. Following replacement of V-302, V-303, or V-304, proceed as follows:

a. Connect a d-c voltmeter with a sensitivity not less than 1000 ohms-per-volt across the terminals of capacitor C-304, with the positive lead of the voltmeter on the grounded terminal of capacitor C-304.

b. Adjust R-307 (figures 5-2 and 5-2A) until the voltage is exactly -300 volts.

c. Check, and if necessary reset 1000 volt supply as described in paragraph 5-19.

5-19. REPLACING V-303 OR V-306. Following replacement of V-303 or V-306:

a. Connect the negative lead of a d-c voltmeter with a sensitivity not less than 1000 ohms-per-volt to the -1000

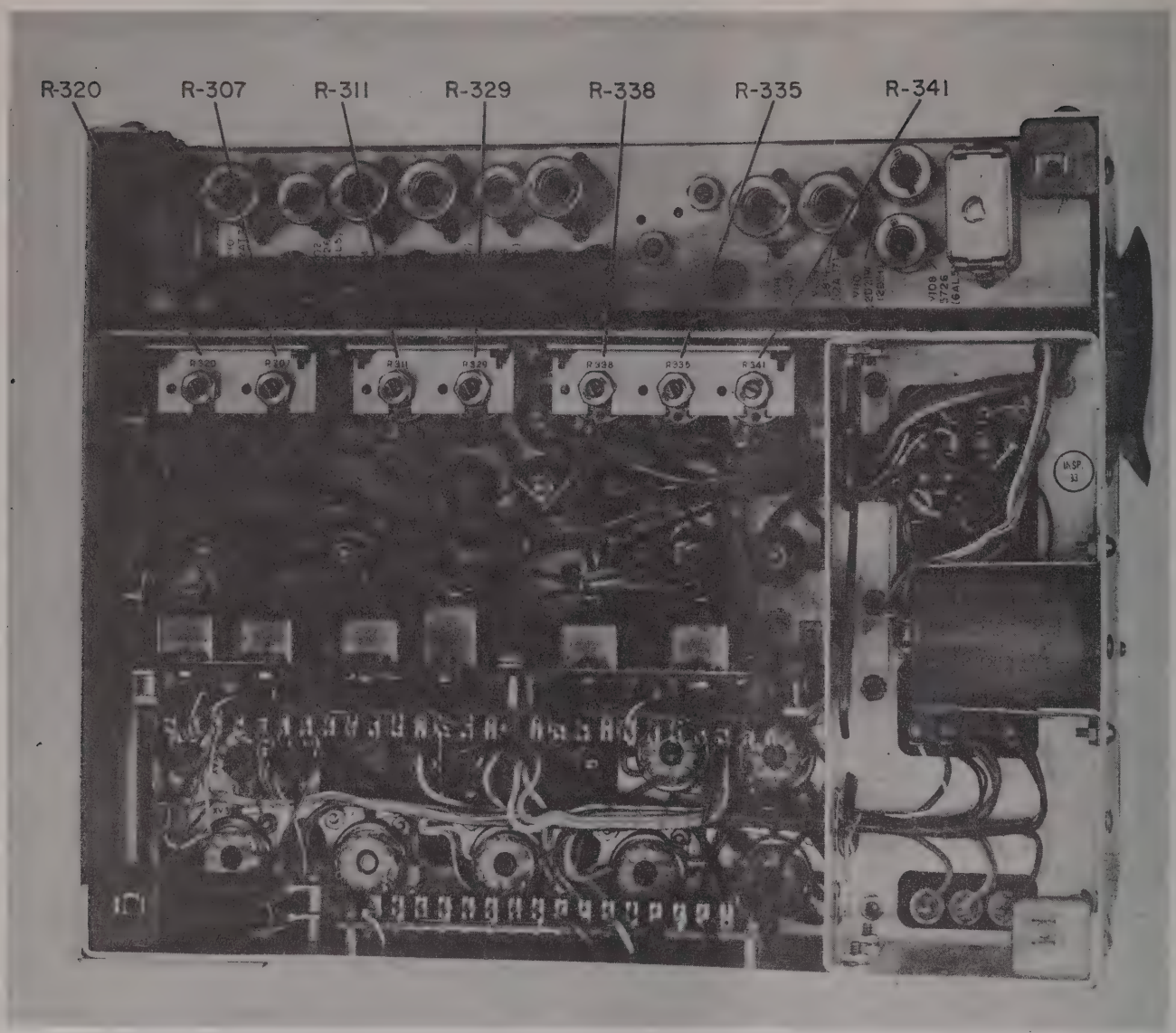


Figure 5-2. Location of Internal Controls, AN/URM-52, Power Supply

volt buss (terminal board under resonator figure 6-9) and the positive lead to ground.

b. Adjust R-320 (figures 5-2 and 5-2A) until voltage is exactly -1000 volts.

5-20. REPLACING V-308, V-309, V-310, V-311 OR V-312. When replacing any one of these tubes:

a. Connect the negative lead of a d-c voltmeter with a sensitivity not less than 1000 ohms-per-volt to terminal 8 of the terminal board under resonator (-1500 volts) and the positive lead to terminal 9 (-1000 volts).

b. Adjust R-335 (figures 5-2 and 5-2A) until the meter indicates exactly -500 volts

c. Following replacement of V-312 check klystron operating current as described in paragraph 5-16.

5-21. REPLACING V-313 OR V-314. Following replacement of either of these tubes:

a. Connect the negative lead of a d-c voltmeter with a sensitivity not less than 1000 ohms-per-volt to the chassis and the positive lead to pin 3 of V-303.

b. Adjust R-338 (figures 5-2 and 5-2A) until the voltage across resistor R-316 measures 0.1 volts. Important, see paragraph 5-16c.

5-22. LUBRICATION.

5-23. The signal generator does not require lubrication other than that given it during its manufacture. The gears used in the instrument are designed to run with only their initial lubrication except where the parts are cleaned by solvent during overhaul.

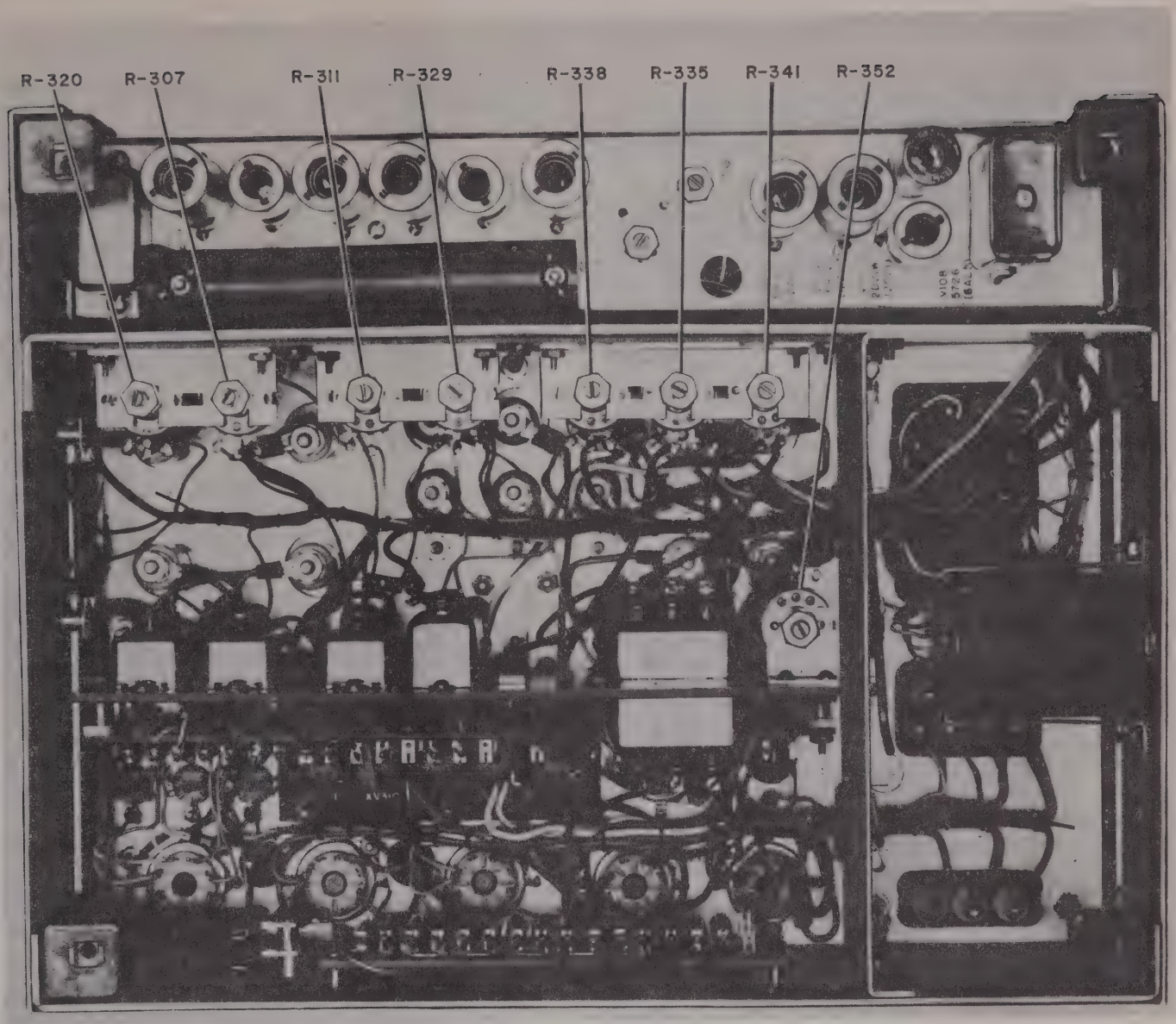


Figure 5-2A. Location of Internal Controls, AN/URM-52A, Power Supply

5-24. PERIODIC INSPECTION.

5-25. It is desirable to make a daily check of the exterior of the instrument. Observe the following points, after removing the signal generator from its transit case:

a. Inspect the exterior for dust, dirt, and corrosion.

b. Check the cables and cords for deterioration, excessive wear, hardness, dryness, cuts, and kinks. Replace cables and cords necessary.

c. Inspect the RF OUTPUT connector, making sure that the fingers of the center contact are not sprung apart.

d. Inspect the remaining connectors, and clean with a cloth.

CAUTION

Do not use emery cloth on electrical parts.

e. Remove grease and oil from cables with a soft cloth dampened with dry cleaning solvent, Federal Specification P-S-661a.

f. Clean the meter glass.

g. Remove grease and dust from the exterior of the dust cover and panel with a soft cloth.

5-26. 30-DAY INSPECTION.

5-27. Approximately once a month a more thorough inspection should be made as follows:

a. Remove the cabinet by placing the instrument face down and loosening the knurled captive screws on the back of the cabinet. Lift cabinet from instrument.

b. Remove and inspect air filter inside cabinet, and replace if necessary.

c. Remove dust and dirt in the vicinity of blower, being careful to prevent dirt from falling into resonator ventilating tube.

d. Inspect all electrical parts for blistering or other signs of excessive heating. Any visible signs of malfunctions should be reported to maintenance activity and corrected before placing signal generator back in service. Check the following points:

1. Make sure all tubes are seated firmly in their sockets.

2. Inspect electrical connections for signs of breaking loose.

3. Tighten all loose mounting nuts, bolts, and set screws.

CAUTION

Do not tighten nuts and bolts without consideration of the strength of the material and the weight they must support. There are various degrees of pressure needed. Clean the chassis with a soft cloth. Do not disassemble the r-f oscillator assembly for the periodic inspection.

5-28. REPLACING CABINET.

5-29. To replace the cabinet, place instrument, panel down, on a low surface. When putting the cabinet in place, use care to prevent the rubber baffle on side of instrument from being folded over by the edge of the cabinet. This will require placing a sheet of thin metal or cardboard between the baffle and the cabinet until the edge of the cabinet passes over the baffle. When the cabinet is in place, securely tighten the four captive screws.

SECTION VI

FIELD AND FASRON MAINTENANCE

6-1. MINIMUM PERFORMANCE STANDARDS.

6-2. GENERAL. The indications, readings and tests described in the following paragraphs serve as minimum standards of performance for the equipment.

6-3. TEST EQUIPMENT REQUIRED. In addition to a d-c voltmeter with a sensitivity not less than 1000 ohms-per-volt, and ohmmeter, the test equipment listed in paragraph 2-2 is required to conduct the following tests.

6-4. ADJUSTMENT OF FRONT PANEL CONTROLS. Unless otherwise noted in the detailed procedure, the front panel controls should be adjusted as follows for each test, after initially setting up the equipment in accordance with paragraph 5-3, steps 1 through 6, inclusive. The equipment should be allowed to warm up for at least ten minutes before starting the tests.

FRONT PANEL CONTROL SETTINGS

CONTROL	SETTING
SIGNAL FREQUENCY control	5000 mc
MOD. SELECTOR switch	CW
OUTPUT ATTEN. control	-7 db
FM AMPLITUDE control	Extreme counter-clockwise position
PULSE WIDTH control	5
PULSE DELAY control	25
PULSE RATE control	100
SYNC SELECTOR switch	X10

6-5. CHECK CHART. Because the set-ups for checking and adjusting certain performance features require the same equipment, the procedure involved are combined under one paragraph later in this section. On the other hand, where no specific adjustments may be made to correct certain other performance factors, the checking procedures are presented in the immediately following paragraphs. In these procedures, the names of controls, connectors, and switch positions on the signal generator are written in capital letters. (See figures 1-2 and 1-2A.) The following Check Chart shows which factors are to be checked under Minimum Performance Standard and the paragraph covering the required procedure.

MINIMUM PERFORMANCE STANDARDS CHECK CHART

To Check	Refer to Paragraph
Range of PULSE RATE control	6-33
Range of PULSE DELAY control	6-34
Pulse shape of RF OUTPUT PULSE	6-35
Synchronization with external pulse signals	6-7
Synchronization with external sine wave signals	6-8
Operation with external pulse modulation	6-10
Operation with external frequency modulation	6-11
Operation with internal frequency modulation	6-12
Calibration of r-f oscillator	6-24
Calibration of power output system	6-29
Pulse shape of output synchronizing pulses	6-13
Power supply regulation	6-14

6-6. EXTERNAL SYNCHRONIZATION.

6-7. PULSE SIGNALS. (See figure 6-1.) To observe the output synchronizing pulses requires the use of a pulse generator with a variable time delay between the pulse output and the sync output so that the entire synchronizing pulse of the signal generator will appear on

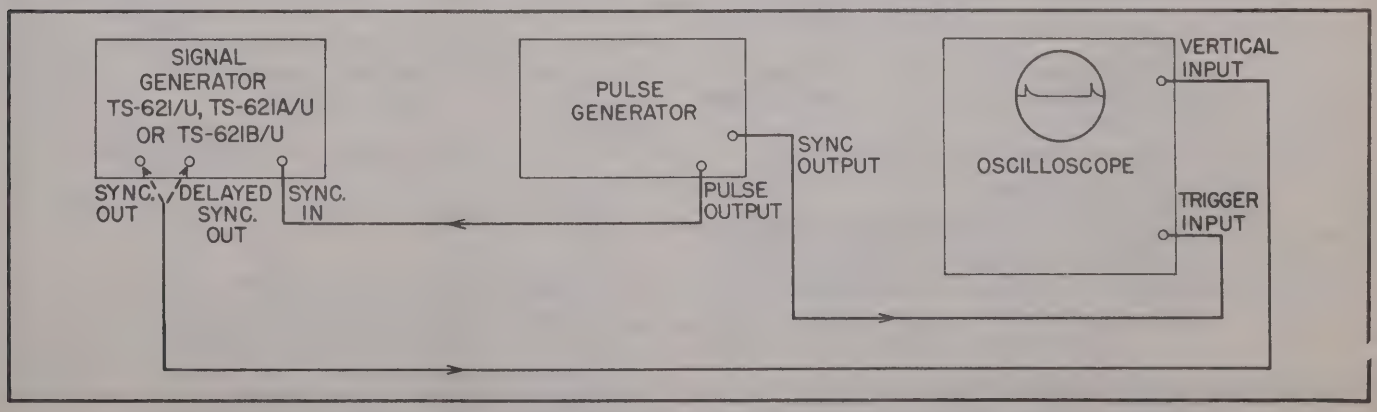


Figure 6-1. Block Diagram of Test Setup for Checking External Pulse Synchronization

the oscilloscope. To check synchronization with external pulse signals, proceed as follows:

a. Connect oscilloscope vertical input alternately to SYNC. OUT and then DELAYED SYNC. OUT connector on signal generator.

b. Set MOD. SELECTOR switch to INT.

c. Synchronize oscilloscope from sync output terminal of pulse generator.

d. Connect pulse output of pulse generator to SYNC. IN connector.

e. Set SYNC. SELECTOR switch to EXT. -.

f. Set pulse width of pulse generator to 0.5 microseconds, and pulse rate of pulse generator to 1000 pps, with negative pulse output. Adjust delay on pulse generator to a value which will permit entire pulse from signal generator, including the leading edge, to be observed on oscilloscope.

g. Adjust voltage output of pulse generator to the minimum which will give reliable synchronization. Measure this voltage.

NOTE

Reliable synchronization is obtained when two or more pulses, separated by a period corresponding to the setting of the pulse rate control, remain on the synchroscope screen with no sign of instability.

h. Repeat step g with positive pulse output from pulse generator, and with SYNC. SELECTOR on EXT. +. Measure the minimum peak voltage for reliable synchronization. Refer to step g for determination of reliable synchronization. The minimum voltage for reliable synchronization should be not more than 5 volts.

6-8. SINE WAVES SIGNALS. (See figure 6-2.) To check synchronization with external sine wave signals, proceed as follows:

a. Connect oscilloscope vertical input alternately to SYNC. OUT and then DELAYED SYNC. OUT connector on signal generator.

b. Set SYNC. SELECTOR switch to ∿.

c. Connect audio oscillator to SYNC. IN connector.

d. Set audio oscillator to 100 cps.

e. Synchronize oscilloscope from audio oscillator.

f. Adjust output voltage from audio oscillator to the minimum required for reliable synchronization and measure this voltage. The minimum voltage required for reliable sine wave synchronization should be not more than 5 volts rms. Refer to paragraph 6-7g for determination of reliable synchronization.

6-9. EXTERNAL MODULATION.

6-10. PULSE MODULATION. (See figure 6-3.) To check operation with external pulse modulation, proceed as follows:

a. Connect RF OUTPUT through the crystal detector to the oscilloscope input.

b. Connect pulse generator to EXT. MOD. connector.

c. Synchronize oscilloscope from sync out terminal of pulse generator.

d. Set MOD. SELECTOR switch to EXT. -.

e. Set the pulse generator to 1000 pps, with negative pulse output, and a pulse length of 5 microseconds.

f. Adjust voltage output of pulse generator to the minimum which will give a full size r-f output pulse (where increasing modulation voltage no longer increases the size of the r-f output pulse.)

g. Repeat step f with MOD. SELECTOR switch on EXT. +, and pulse generator set for positive pulse output. Record the minimum voltage necessary for satisfactory

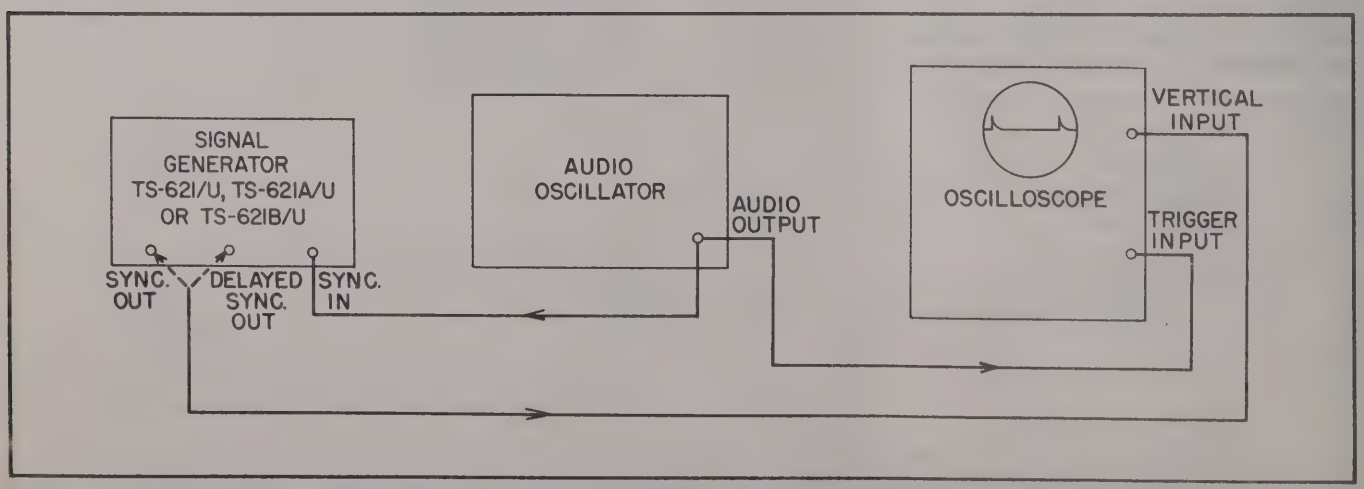


Figure 6-2. Block Diagram of Test Setup for Checking External Sine Wave Synchronization

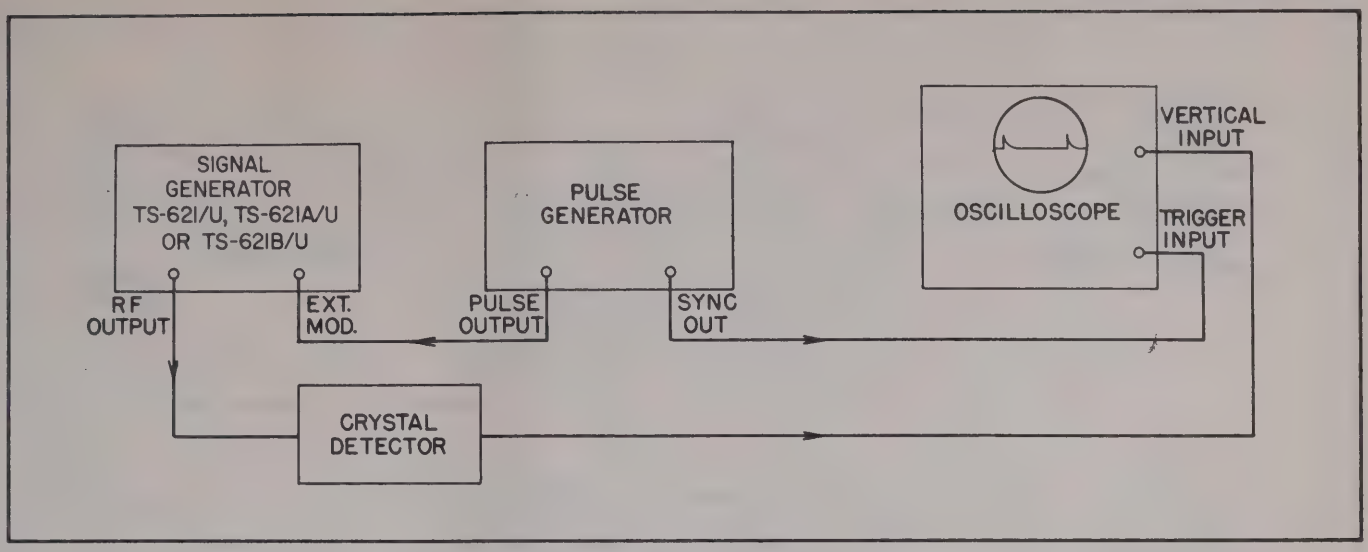


Figure 6-3. Block Diagram of Test Setup for Checking External Pulse Modulation

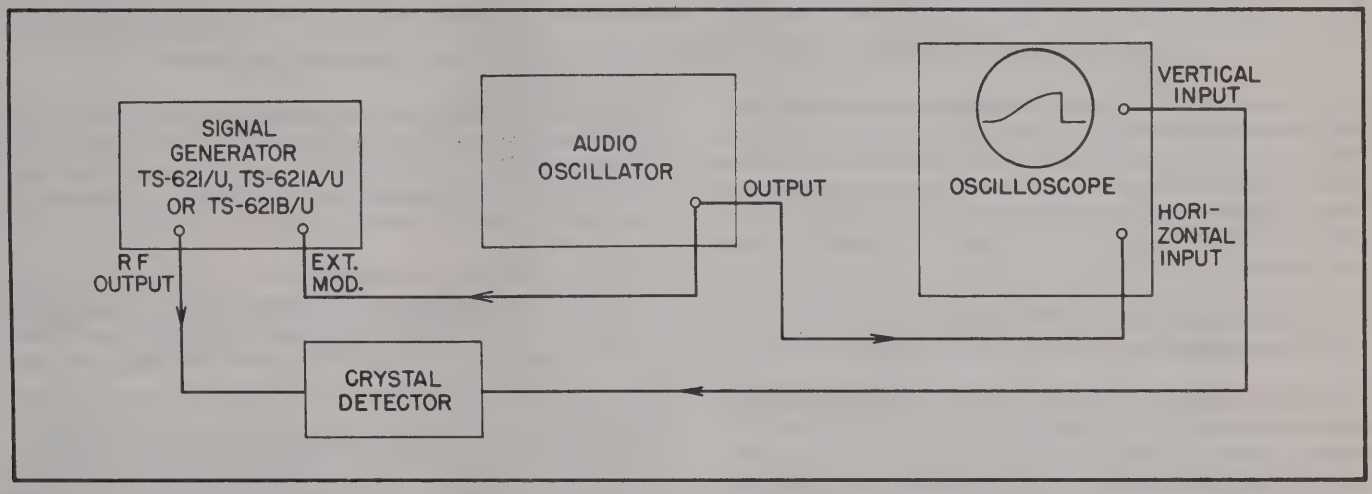


Figure 6-4. Block Diagram of Test Setup for Checking External Frequency Modulation

modulation. The minimum peak amplitude necessary for satisfactory modulation should be not more than 15 volts.

6-11. FREQUENCY MODULATION. (See figure 6-4.) To check operation on frequency modulation, proceed as follows:

a. Connect RF OUTPUT through the crystal detector to the oscilloscope input.

b. Connect output of audio oscillator to EXT. MOD. connector. Synchronize oscilloscope from audio oscillator.

c. Set MOD. SELECTOR switch to EXT. FM.

d. Adjust the audio oscillator for approximately 10 volts output at 1000 cps.

e. Observe the pattern on the oscilloscope which should represent a portion of the repeller mode. As the FM AMPLITUDE control is varied, the pattern should change in length. The characteristics of the klystron do not lend themselves to linear frequency modulation. The pattern observed on the oscilloscope in this procedure results from amplitude modulation accompanying the frequency modulation, but is positive assurance that the latter is taking place.

6-12. INTERNAL FREQUENCY MODULATION. (See figure 6-5.) To check operation on internal frequency modulation, proceed as follows:

a. Connect RF OUTPUT through the crystal detector to the oscilloscope input.

b. Set MOD. SELECTOR switch to INT. FM. SYNC. SELECTOR to X10, and PULSE RATE control to 100.

c. Synchronize oscilloscope from SYNC. OUT connector.

d. Slowly adjust FM AMPLITUDE control and observe change in amplitude of sawtooth pattern on oscilloscope. This indicates proper operation of the internal frequency modulation circuits. Refer to paragraph 6-11e for explanation of oscilloscope pattern.

6-13. PULSE SHAPE OF OUTPUT SYNCHRONIZING PULSES. (See figure 6-1.) Pulse shape includes such

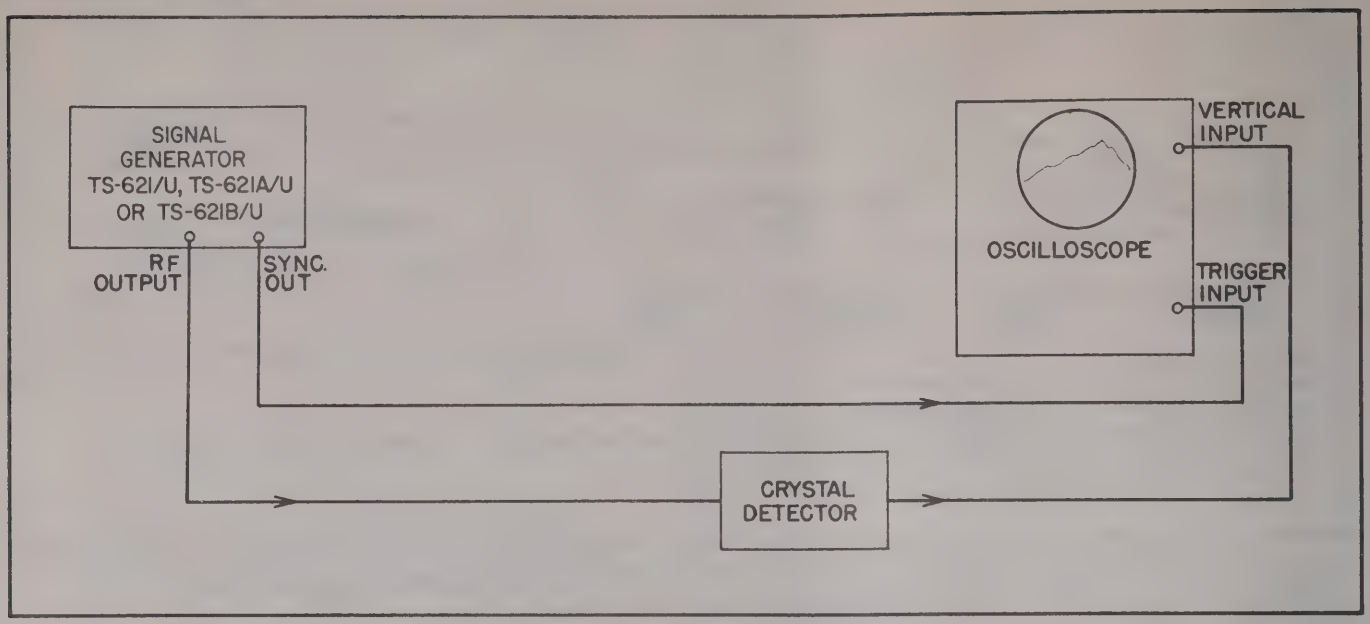


Figure 6-5. Block Diagram of Test Setup for Checking Internal Frequency Modulation

factors as pulse width, rise and decay time, and flatness. To observe the output synchronizing pulses requires the use of a pulse generator with a variable time delay between the pulse output and the sync output so that the entire pulse of the signal generator will appear on the oscilloscope. To check the SYNC. OUT pulse, proceed as follows:

a. Connect the SYNC. OUT connector to oscilloscope vertical input.

b. Connect pulse output of pulse generator to SYNC. IN connector.

c. Set pulse generator to 1000 pps, negative output.

d. Synchronize oscilloscope to sync pulse output from the pulse generator.

e. Set the delay on pulse generator to a value which will permit the entire pulse from the signal generator, including the leading edge, to be observed on the oscilloscope.

f. Set SYNC. SELECTOR switch to EXT. -.

g. Connect a load consisting of 1000 ohm resistor in parallel with a 500 uufd capacitor across the SYNC. OUT connector.

h. Measure the peak amplitude and the width of the SYNC. OUT pulse. The peak amplitude should be greater than 25 volts and less than 100 volts. The width should be greater than 0.5 and less than 5 microseconds.

i. Measure the rise and decay times, observe the flatness of the top of the pulse, and observe the magnitude and direction of any extraneous signals. The rise and decay times should each be less than 1 microsecond when measured between points that are 10 percent and 90 percent of the maximum amplitude of the initial rise. Between points on the initial rise and the final decay that are 90 percent of the maximum amplitude of the initial rise, the amplitude should be within 90 to 100 percent of the maximum amplitude of the initial rise. The final decay should have no rise in excess of 10 percent of the maximum amplitude of the initial rise.

j. To check the DELAYED SYNC. OUT pulse, connect the oscilloscope vertical input and the load to the DELAYED SYNC. OUT connector instead of the SYNC. OUT connector, and repeat the measurements described in steps h and i.

6-14. POWER SUPPLY REGULATIONS AND RIPPLE. (See figure 6-6a and 6-6b.) To check the operation of the power supply under variable line voltage, proceed as follows:

a. Connect the cable attached to the POWER INPUT connector to the output of a variable auto-transformer, and connect the input of the audio-transformer to a nominal 115 volt a-c source. Connect an a-c voltmeter across the output of the auto-transformer. (See figure 6-6a.)

b. Measure the -300 volt, the -1000 volt, and the -1500 volt power supply voltages while varying the input voltage to the signal generator from 103.5 to 126.5 volts. These voltages should remain within approximately 1.0 percent of their nominal values.

c. Using a sensitive a-c vacuum tube voltmeter such as a Hewlett-Packard Model 400 C (figure 6-6b), measure the a-c ripple on each d-c voltage with the same line voltage change as in step b. The ripple voltage should be less than 40 mv.

6-15. SYSTEMS ANALYSIS.

6-16. GENERAL. This section contains trouble-shooting data and step-by-step procedures necessary to determine specific circuit failures. Refer to Section V for information on tube replacement.

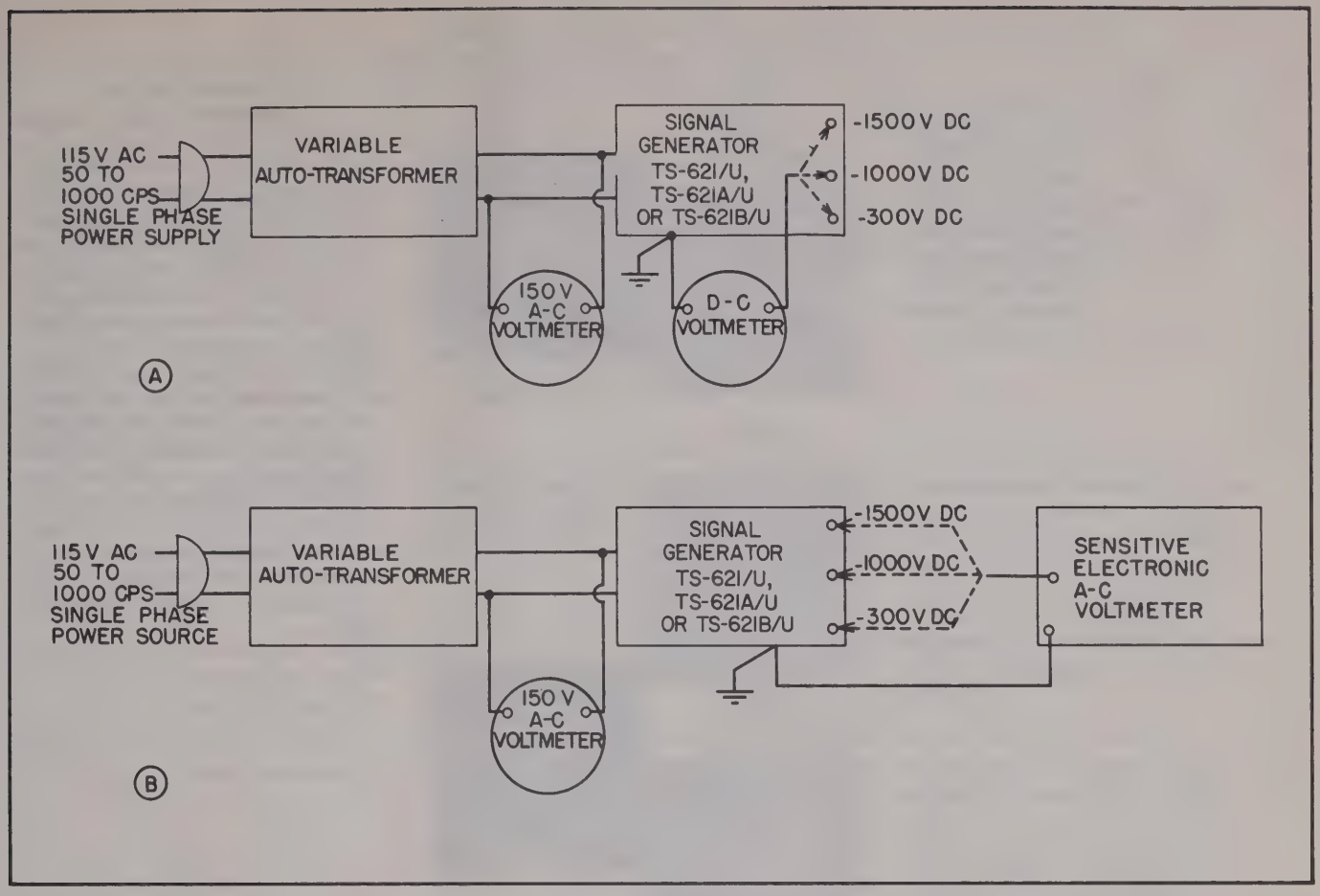


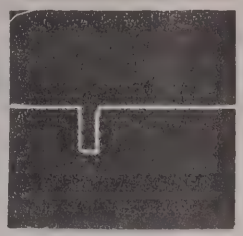
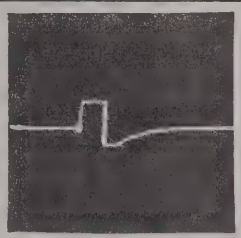
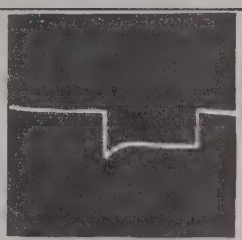
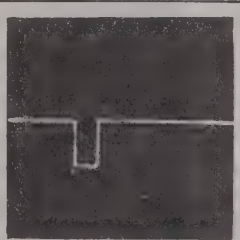
Figure 6-6. Block Diagram of Test Setup for Checking Power Supply Regulation and Ripple

6-17. TEST EQUIPMENT REQUIRED. In addition to a 20,000 ohm-per-volt voltmeter and ohmmeter test set, the special test equipment listed in paragraph 2-2 will be mentioned as required.

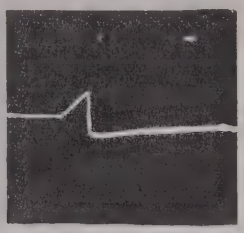
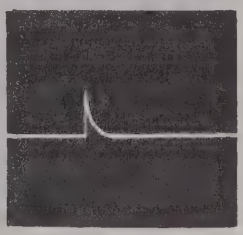
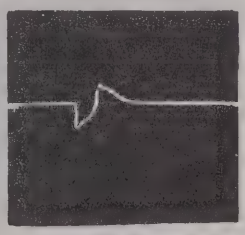
6-18. TEST POINTS. Refer to Paragraph 5-7 for explanation of test point symbols.

6-19. PULSER TROUBLE-SHOOTING CHART. The following chart is designed to aid in isolating a malfunction in the pulser section of the signal generator. It is assumed here that it has been determined that the source of the malfunction is in the pulser section as determined by the procedure outlined in paragraph 5-8. Refer to paragraph 6-20 for trouble-shooting of power supply. In general, the trouble-shooting is carried out by observation of waveforms on an oscilloscope connected, successively, to various points in the signal generator. When a malfunction is observed, further investigation is carried out with a voltmeter and an ohmmeter. Refer to voltage and resistance diagrams, figure 7-5. It is assumed that the equipment has been allowed to warm up for at least 10 minutes and that the calibration procedure given in paragraph 5-3, steps 1 through 6, has been followed, or, with faulty equipment, followed to the point where normal procedure fails to give normal indications. Unless otherwise specifically stated in the chart, the controls are adjusted as in paragraph 5-8, after the initial calibration procedure. The oscilloscope should be set for 100 microsecond sweep, unless otherwise stated under Check Procedure. To view the leading edges of pulses coincident with the SYNC. OUT pulse, it is necessary to synchronize the signal generator and oscilloscope separately from an outside source such as the pulse generator specified in paragraph 2-2, and to delay the synchronizing of the signal generator by a convenient amount. The voltages given for the oscilloscope patterns under Normal Indication are peak-to-peak voltages.

PULSER TROUBLE-SHOOTING CHART

Step	Test Points	Control Positions	Check Procedure	Normal Indication	Possible Cause of Malfunction
1		Refer to Control Setting Chart, paragraph 5-3. Advance POWER SET control until reading is obtained on POWER SET meter.	Connect RF OUTPUT through crystal detector to oscilloscope input.	 0.09 volts	R-F oscillator tube V-114. If oscilloscope indication is zero, but POWER SET meter reading is satisfactory; check attenuator resistor R-203 by measuring the d-c resistance between the center and outer conductors of RF OUTPUT connector. If zero indication is obtained on POWER SET meter as well as on oscilloscope, turn MOD. SELECTOR switch to CW position. If indication is normal on CW but 0 on INT the malfunction lies in the pulsing circuits prior to V-112. If CW indication is also 0 the malfunction may be with V-114 or associated circuits of power supply.
2		Same as step 1.	Connect oscilloscope to pin 1 of tube V-113 in series with a 0.01 mfd 1000 volt capacitor.	 47 volts	V-113, V-111, V-110 circuits. Proceed with Step 3.
3		Same as step 1, except MOD. SELECTOR switch on SQ. WAVE.	Same as step 2, but oscilloscope sweep set for 1000 microseconds.	 55 volts	If normal indication is obtained in this type of operation, cause of trouble is not with V-113 circuits.
4		Same as step 1, return MOD. SELECTOR switch to INT.	Connect oscilloscope to pin 1 of tube V-111. Return oscilloscope sweep setting to 100 microseconds.	 90 volts	If indication is normal and abnormal indication was obtained in step 3, check: V-113, R-163, R-164, R-165, R-166, C-142. If indication is abnormal, proceed with step 5.

PULSER TROUBLE-SHOOTING CHART (Cont)

Step	Test Points	Control Positions	Check Procedure	Normal Indication	Possible Cause of Malfunction
5		Same as step 1.	Connect oscilloscope to pin 7 of V-111.	 22 volts	Tube V-111 or tube V-110, or associated circuit elements. Proceed with step 6.
6		Same as step 1.	Connect oscilloscope to pin 2 of V-110.	 125 volts	If indication is normal, and indication in step 5 was abnormal, check V-111 circuit elements. If indication is abnormal, proceed with step 7. If indication is normal and malfunction appeared at DELAYED SYNC OUT connector, proceed with step 21.
7		Same as step 1.	Connect oscilloscope to pin 1 of V-109.	 220 volts	If indication is normal, and abnormal indication was obtained in step 6, check tube V-110, or tube V-108, or associated circuit elements. If indication is abnormal, proceed with step 8.
8		Turn MOD. SELECTOR switch to EXT. + position.	Connect pulse generator to EXT. MOD. connector. Set pulse generator for + pulse output, with an amplitude of at least 15 volts peak, a pulse rate of 1000 pps, and pulse width of 10 microseconds. Connect oscilloscope to output of pulse generator, then to pin 1 of V-109.	Oscilloscope indication should be the same at pin 1 of V-109 as at output of pulse generator, except for inversion of waveform.	If there is an appreciable difference between the waveforms found at pin 1 of V-109 and at output of pulse generator, except for inversion, check tube V-109, associated circuit elements and voltages. If zero indication is obtained at pin 1 of V-109, proceed with step 9. If indication is normal, proceed with step 10.
9		Same as step 8.	Connect oscilloscope to pin 2 of V-109.	Oscilloscope indication should be the same at pin 2 of V-109 as at output of pulse generator.	If indication is normal, and zero indication was obtained in step 8, check: R-145, R-146, R-147, R-189, C-124, C-125, C-126, C-129. If indication is zero, check C-123.

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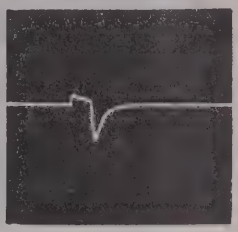
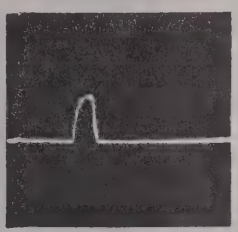
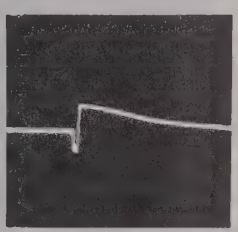
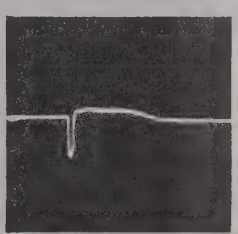
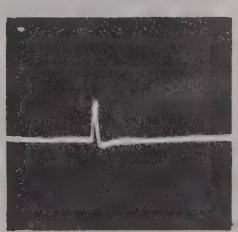
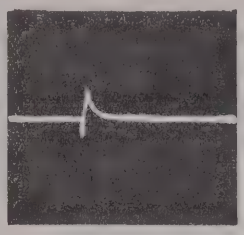
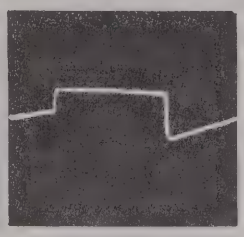
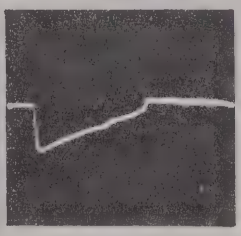
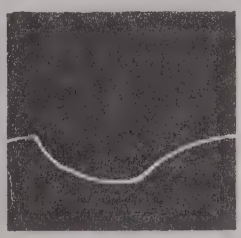
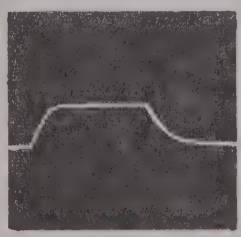
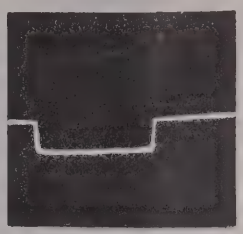
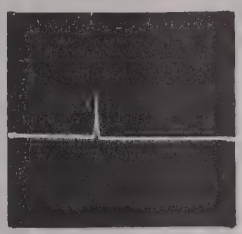
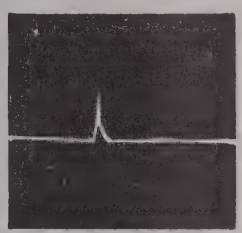
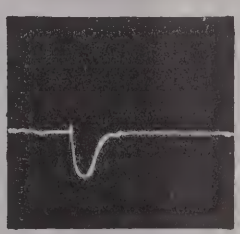
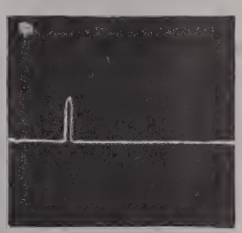
PULSER TROUBLE-SHOOTING CHART (Cont)

Step	Test Points	Control Positions	Check Procedure	Normal Indication	Possible Cause of Malfunction
10		Same as step 1.	Same as step 9.	 52 volts	Tubes V-106, or tube V-107, or associated circuit elements. Proceed with step 11.
11		Same as step 1.	Connect oscilloscope to pin 6 of V-107.	 220 volts	If indication is normal, and abnormal indication was obtained in step 10, check C-122. If indication is abnormal, proceed with step 12.
12		Same as step 1.	Connect oscilloscope to pin 1 of V-106.	 150 volts	If indication is normal, and abnormal indication was obtained in step 11, check: tubes V-107 and V-106, R-133, R-134, R-135, R-136, R-137, R-138, R-139, R-140, C-120. If indication is abnormal, proceed with step 13.
13		Same as step 1.	Connect oscilloscope to pin 1 of V-105.	 105 volts	If indication is normal, and abnormal indication was obtained in step 12, check C-119, R-131, and R-132. If indication is abnormal, proceed with step 14.
14		Same as step 1.	Connect oscilloscope to pin 1 of V-104.		If indication is normal, and abnormal indication was obtained in step 13, check C-116, R-125, R-126. If indication is abnormal, proceed with step 15. If indication is normal, and malfunction appeared at SYNC OUT connector, proceed with step 24.

PULSER TROUBLE-SHOOTING CHART (Cont)

Step	Test Points	Control Positions	Check Procedure	Normal Indication	Possible Cause of Malfunction
15		Same as step 1.	Connect oscilloscope to pin 2 of V-104.	 52 volts	If indication other than zero is obtained, and abnormal indication was obtained in step 14, check: tube V-104, R-120, R-121, R-122, R-123, R-124, C-113, C-114. If indication is zero, proceed with step 16.
16		Same as step 1.	Connect oscilloscope to pin 7 of V-103. Adjust oscilloscope sweep for 200 microseconds.	 270 volts	If indication is normal, and abnormal indication was obtained in step 15, check C-112. If indication is abnormal, proceed with step 17.
17		Same as step 1.	Connect oscilloscope to pin 2 of V-103. Leave oscilloscope sweep on 200 microseconds.	 230 volts	Tube V-103, R-107, R-108, R-109, R-110, R-111, R-113, R-114, R-115, C-105, C-109. If none of these is defective, and malfunction appeared with SYNC. SELECTOR in either of the EXT. positions, proceed with step 18.
18		SYNC. SELECTOR to EXT. -	Connect pulse generator to SYNC. IN connector. Set pulse generator for pulse rate of 1000 pps, pulse width of 5 microseconds, and pulse output to negative with an amplitude of at least 5 volts peak. Adjust oscilloscope sweep for 10 microseconds. Connect oscilloscope to pin 6 of V-101.	 270 volts	If indication is normal, check: tube V-102, C-104, C-108, C-111, R-106, R-108. If indication is abnormal, proceed with step 19.
19		Same as step 18.	Same as step 18. Connect oscilloscope to pin 1 of V-101.	 65 volts	If indication is normal, check C-102. If malfunction appeared with SYNC SELECTOR in EXT. + position, check: C-103, C-107. If indication is abnormal, proceed with step 20.

PULSER TROUBLE-SHOOTING CHART (Cont)

Step	Test Points	Control Positions	Check Procedure	Normal Indication	Possible Cause of Malfunction
20		Same as step 18.	Connect oscilloscope to pin 2 of V-101.	 14 volts	C-101, R-101, R-102.
21		Same as step 1.	Connect oscilloscope to pin 8 of V-109.	 62 volts	If indication is other than zero, check: tube V-109, C-141, R-198, R-199. If none of these is at fault, or indication is zero, proceed with step 22.
22		Same as step 1.	Connect oscilloscope to pin 6 of V-115.	 95 volts	If indication is normal, and abnormal indication was obtained in step 21, check C-140, R-197. If indication is abnormal, proceed with step 23.
23		Same as step 1.	Connect oscilloscope to pin 1 of V-115. Oscilloscope sweep set to 10 microseconds.	 22 volts	Check: tube V-115, C-138, C-139, R-192, R-193, R-194, R-195, R-196.
24		Same as step 1.	Connect oscilloscope to pin 8 of V-105.	 55 volts	If indication is normal, and abnormal indication appeared at SYNC OUT connector, check: C-118, R-130. If indication is abnormal, check tube V-105, C-117, R-128, R-129.

6-20. POWER SUPPLY TROUBLE SHOOTING. In general, power supply trouble will usually show up as poor or unstable performance in all positions of the MOD. SELECTOR switch. Measure all output voltages from power supply. Refer to voltage diagrams, figure 7-5. Check tubes and replace any which appear doubtful. If necessary, follow the procedure given in paragraphs 5-16, and 5-18 through 5-21. If these adjustments cannot be made or do not clear the trouble, measure power supply tube socket voltages, and finally, resistances. Refer to resistance diagram, figure 7-4.

WARNING

Exercise care when making voltage measurements. High voltages which may be fatal are present in certain portions of the equipment. The power supply is wired so that the positive sides of two of the developed voltages are at, or near, chassis (ground) potential, while in the third, both the positive and negative sides of the voltage are removed from ground potential. This is contrary to the usual practice of connecting the negative side of the power supply to the chassis. Be especially careful when making measurements in which neither the positive or negative side of the meter is at chassis potential. In such cases, and in ALL HIGH VOLTAGE measurements, turn the equipment OFF before attaching meter. Then turn ON. Make measurement and turn equipment OFF before disconnecting meter.

6-21. REMOVAL, REPLACEMENT, AND ADJUSTMENT OF INDIVIDUAL SUBASSEMBLIES, PARTS, AND CIRCUITS.

6-22. REMOVING V-114. To remove V-114, first remove the instrument from its cabinet in accordance with paragraph 5-10, then proceed as follows:

a. Place the signal generator, with the cover removed, in the position shown in figure 6-7A for ease in reaching the tube. The bracket below the resonator is shown removed only to simplify this photograph. It need not be removed when replacing V-114.

b. Remove the socket housing cap screws and lock washers (item 1 and 2, figure 6-7) with the Allen wrench located in the Fahnstock storage clip (figure 2-1) in the rear of the chassis. Pull the housing (item 3, figure 6-7) back until the tube socket is exposed.

c. Pull straight back on the socket until it is free of the tube base.

CAUTION

Be very careful NOT TO APPLY LATERAL PRESSURE when removing the socket.

d. Unscrew the sleeve (4) that covers the body of the klystron tube and remove it. Be careful not to push the klystron sideways in the cavity.

e. Turn the tube (6) clockwise and pull straight back, removing it from the cavity. Do not attempt to rock the tube or move it sideways. To do so may break the glass seals of the tube.

f. Remove semi-circular sections of the clamping ring (5). When the sleeve is removed, one or both of the semi-circular sections of the clamping ring (5) may come out. If they do not, do not attempt to pry them out. They will come automatically when the tube is removed.

g. Unscrew the hex nut (7) at the entrance to the cavity using socket wrench stowed beside tubes on pulser deck (figure 2-1). Remove the spring (8) below the hex nut. Do not reuse this same spring except in an emergency. New springs are supplied with the equipment for tube replacement and are located in the plastic envelopes inside the transit case.

h. If the cavity ventilator connector (11) protrudes within cavity, remove connector nut (9) and disengage pipe (10). Loosen set nut (12) and back out the connector until flush with inside face of cavity plate. Tighten set nut (12) lightly, as the connector may be used for tuning when recalibrating the instrument (paragraph 6-25).

6-23. INSTALLING NEW V-114. The procedure for installating the new klystron V-114 is as follows: (see figure 6-7). Prior to installing a new klystron, personnel should practice by reinstalling the old klystron. The proper thrust and twist required to push the klystron past the spring may then be learned by practice.

CAUTION

When inserting the tube always keep it straight in line with the cavity. Never work it from side to side. To do so will cause possible damage to the glass seals of the tube.

a. Install new spring in entrance to the cavity so that the ends just meet and form a complete circle.

b. Thread hex nut into cavity until it is seated very lightly against the spring. Press the spring back under the nut all around so that the spring forms as nearly a perfect circle as possible. Tighten the nut very slightly to hold the spring in this position.

c. Observing the above caution, insert the klystron tube into the cavity and push it forward until it engages the spring. Firmly press the tube straight into the cavity, giving it a slight clockwise twist. This will cause the tube to compress the spring slightly, slide by the spring and seat firmly against the cavity proper. Practice with the old klystron, as recommended, will enable the technician to feel when the tube is properly installed.

d. Tighten the hex nut well with the fingers, or very lightly with the wrench.

e. Insert the split clamping ring, making certain that the sections of the ring encircle the grid ring which can be seen just inside the hex nut. When the ring is in the

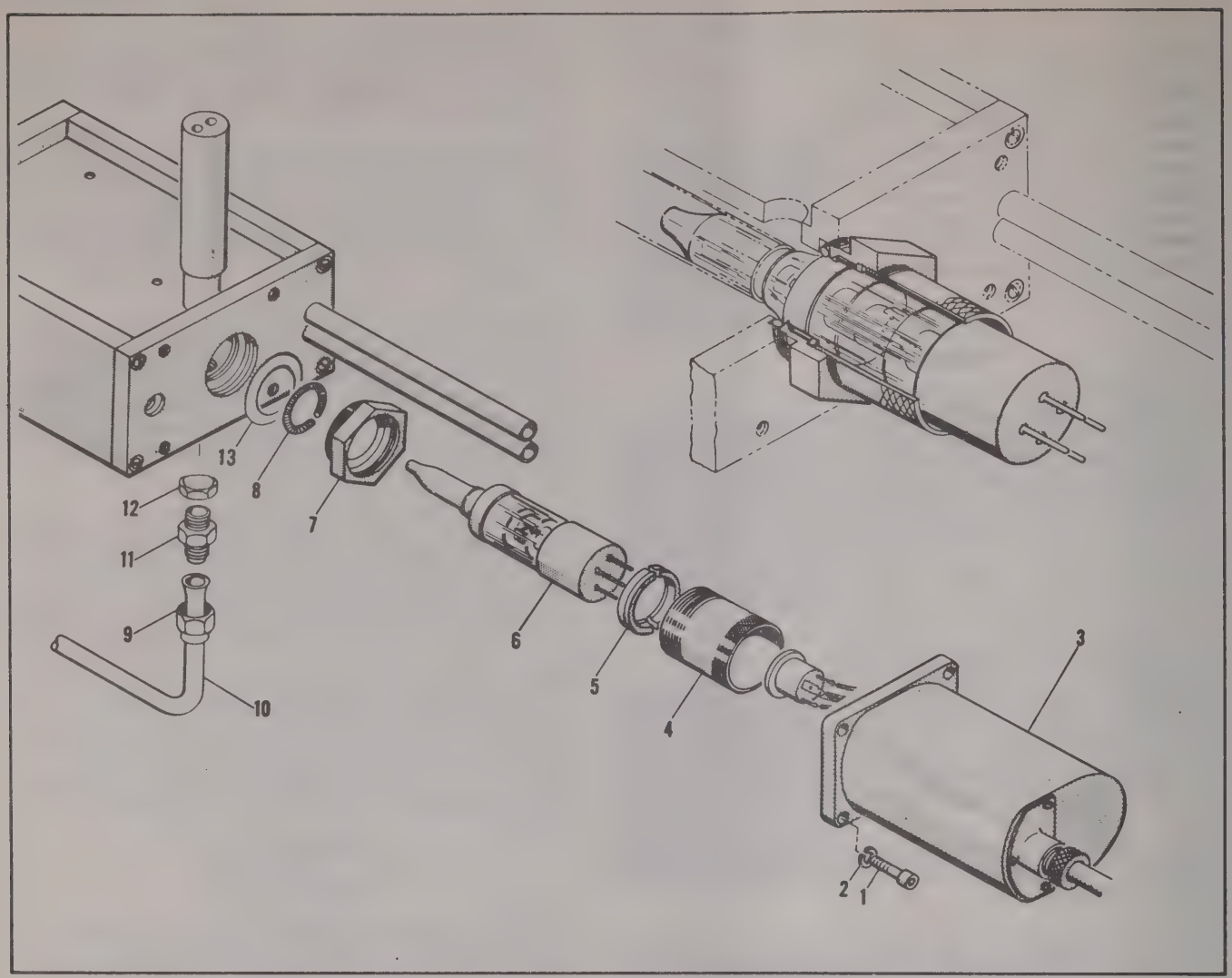


Figure 6-7. Klystron Assembly, Exploded View

1. Cap screw
2. Lock washer
3. Socket housing
4. Sleeve
5. Clamping ring
6. Klystron tube, V-114
7. Hex nut
8. Spring
9. Connector nut
10. Ventilating pipe
11. Ventilating pipe connector
12. Set nut
13. Washer

proper position, three or four threads should be visible between the clamping ring and the outside face of the nut.

f. Thread the cover sleeve into the hex nut so that it seats against the clamping ring, causing the ring to grip the klystron grid ring. Tighten by hand, moderately tight.

g. Install the tube socket, pressing it straight onto the tube.

h. Position the socket housing and attach with the four socket head screws originally removed and tighten with the long Allen wrench. Replace all Allen wrenches in the Fahnstock storage clips, and fasten socket wrench in place on pulser deck (figure 2-1).

6-24. ADJUSTMENTS FOLLOWING REPLACEMENT OF V-114. Following replacement of V-114 it is important that two adjustments be made as soon as the instrument is turned on. The following procedure is recommended.

a. With MOD. SELECTOR switch on OFF, turn on signal generator with new V-114 installed.

b. Check the voltage of the -1000 volt supply as described in paragraph 5-19.

c. Check the voltage of the -300 volt supply as described in paragraph 5-18.

d. With MOD. SELECTOR switch on CW, adjust the klystron beam current to 20 milliamperes as described in paragraph 5-16.

e. With MOD. SELECTOR switch on OFF, adjust the klystron cutoff bias as described in paragraph 5-16.

NOTE

The following three adjustments track the repeller voltage with the frequency drive mechanism. In general, this is done by observing square wave or pulsed output throughout the r-f range and making adjustments to give most dependable output.

f. With the MOD. SELECTOR switch on CW, tune signal generator to 7400 megacycles.

g. Adjust R-170 (on frequency control casting, figure 6-8) for peak power output as observed on POWER SET meter.

h. Reduce peak power output one db by readjusting R-170. This reduction should be made by turning in the direction in which the power output decreases most slowly.

i. Tune signal generator to 4400 megacycles.

j. Adjust R-173 and/or R-178 (figure 6-8) for the indication described in steps g and h above.

k. Tune signal generator to 3800 megacycles.

l. Adjust R-175 (figure 6-8) as described in steps g and h above.

m. Repeat the adjustments described above, as there is some degree of interaction, particularly between the 4400 and 3800 megacycle adjustments.

n. Connect RF OUTPUT to the vertical amplifier of oscilloscope through the crystal detector.

o. Observe square wave operation throughout the entire r-f range. Should any weak or unstable points be noticed, slightly readjust repeller voltage for best operation. If operation is not improved, readjust klystron anode current as described in paragraph 5-16.

6-25. FREQUENCY CALIBRATION. The signal generator will be operative following replacement of V-114 as described in paragraphs 6-22, 6-23, and 6-24. However, the accuracy of the MEGACYCLES dial may be lessened. Recalibration of the signal generator is described below and should be performed as soon as possible. For emergency use of the signal generator prior to recalibration, performance should be normal where exact calibration is not required. If it is desired to recalibrate the equipment, follow the procedure given below. An indicating frequency meter, accurate to within better than ±1 percent, is required to check and adjust the accuracy of the MEGACYCLES dial. Proceed as follows:

a. With MOD. SELECTOR switch on CW, allow at least 20 minutes warm-up prior to checking the calibration.

b. Measure frequency of r-f output of signal generator with MEGACYCLES dial set to the following frequencies: 3800, 4000, 5000, 6000, and 7500 megacycles. Indication of MEGACYCLES dial should be within ±1 percent of the actual frequency. If it is not, proceed with step c.

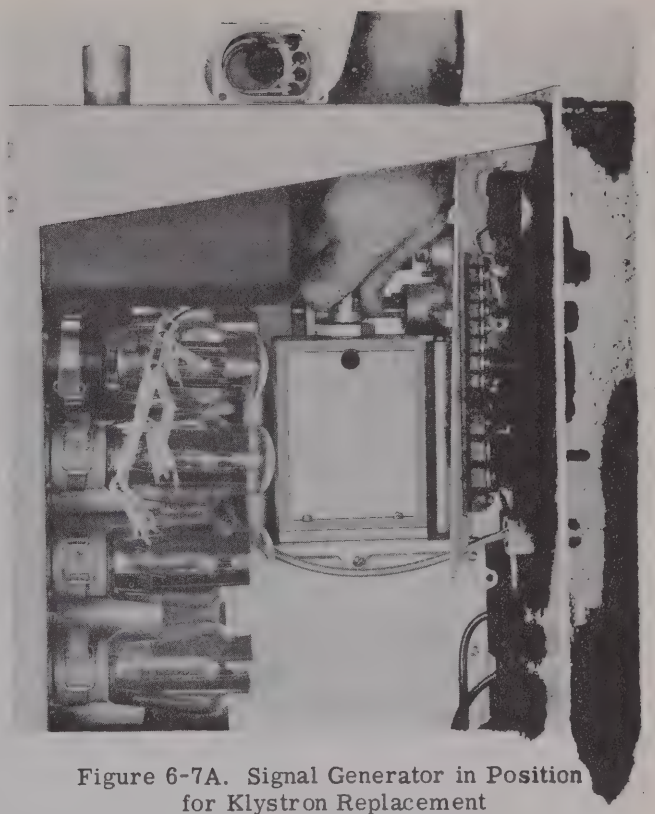


Figure 6-7A. Signal Generator in Position for Klystron Replacement

c. Adjust the frequency meter to 7650 megacycles.

d. Tune the signal generator until indication is obtained on frequency meter. If it is not possible to obtain an indication at 7650 megacycles by means of MEGACYCLES dial, loosen set screws (figure 6-9) holding plunger rods in plunger support bar of frequency drive assembly and move plunger into cavity until an indication is obtained on frequency meter. DO NOT COCK THE PLUNGER IN THE CAVITY. Tighten set screws.

e. Adjust frequency meter to 7500 megacycles.

f. Tune signal generator until indication is obtained on frequency meter. The MEGACYCLES dial of signal generator should indicate 7500 megacycles.

g. Check the overall accuracy of MEGACYCLES dial, and, if necessary, slip the dial to bring into best calibration. If accuracy is not within ±1 percent, use the ventilating pipe connector (figure 6-8A or 6-9) as tuning plug as an aid toward bringing the high frequency end of MEGACYCLES dial into calibration. This connector acts as a vernier frequency adjustment. Before turning the connector, loosen the locknut and ventilating pipe. When the frequency has been brought to 7500 megacycles, tighten the locknut.

h. If adjusting the connector does not correct the high-frequency calibration, another klystron should be tried.

6-26. REMOVING ATTENUATOR PROBE ASSEMBLY. (See figures 6-8 and 6-10.) Power from the resonator is coupled to the RF OUTPUT connector at the front panel through an assembly consisting of the panel connector, a length of RG-55/U cable, and the attenuator

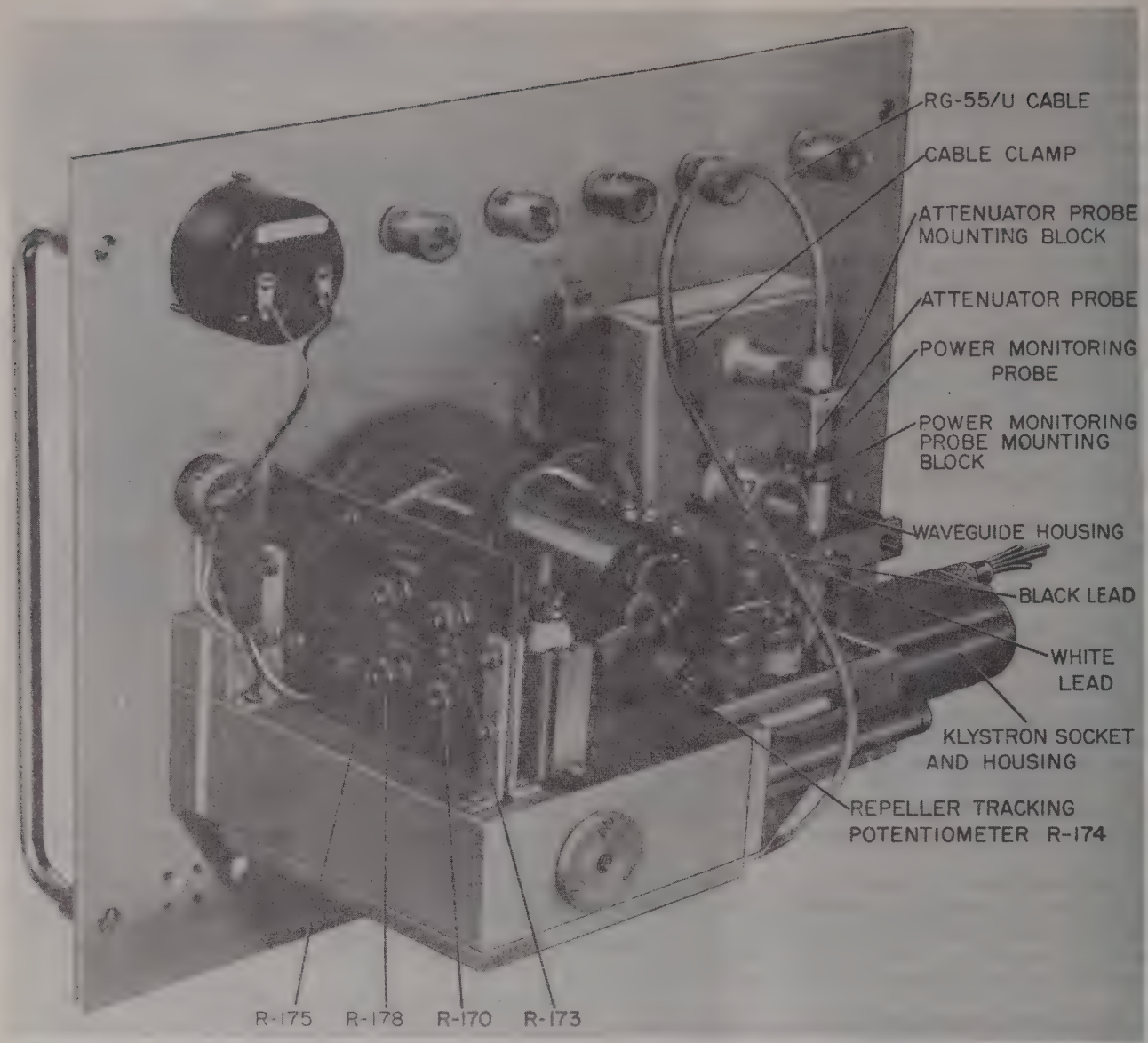


Figure 6-8. Rear View of Panel Assembly and Location of Repeller Voltage Controls

probe. Inside the attenuator probe is a special resistor, R-202, which consists of a platinum-coated glass rod 0.03 inch in diameter. This resistor should normally last for the life of the equipment even if subjected to shock and vibration. However, should the resistor become broken or otherwise defective, the complete attenuator assembly must be replaced. The ASO stock number for the replacement assembly is R16HWP-618BM114. Other service stock numbers will be assigned at a later time. If the glass rod becomes broken, the following two symptoms will usually be present. No r-f output will be obtained or the d-c resistance between the center pin of the RF OUTPUT connector and ground will be very large. If the glass rod is not defective, the resistance will be 85 to 125 ohms. To remove the assembly, proceed as follows:

a. Remove the four screws holding RF OUTPUT connector to front panel.

b. Release attenuator cable from under cable clamp.

c. Remove mounting screw (figure 6-10) which holds mounting block on attenuator probe to end of attenuator rack gear (figure 6-10).

d. Lift mounting block and probe from circular waveguide housing (figure 6-8). Use care in handling attenuator probe (figure 6-8). The glass rod resistor can be broken by twisting the cable.

e. The attenuator probe assembly is replaced in accordance with the procedure in paragraph 6-29.

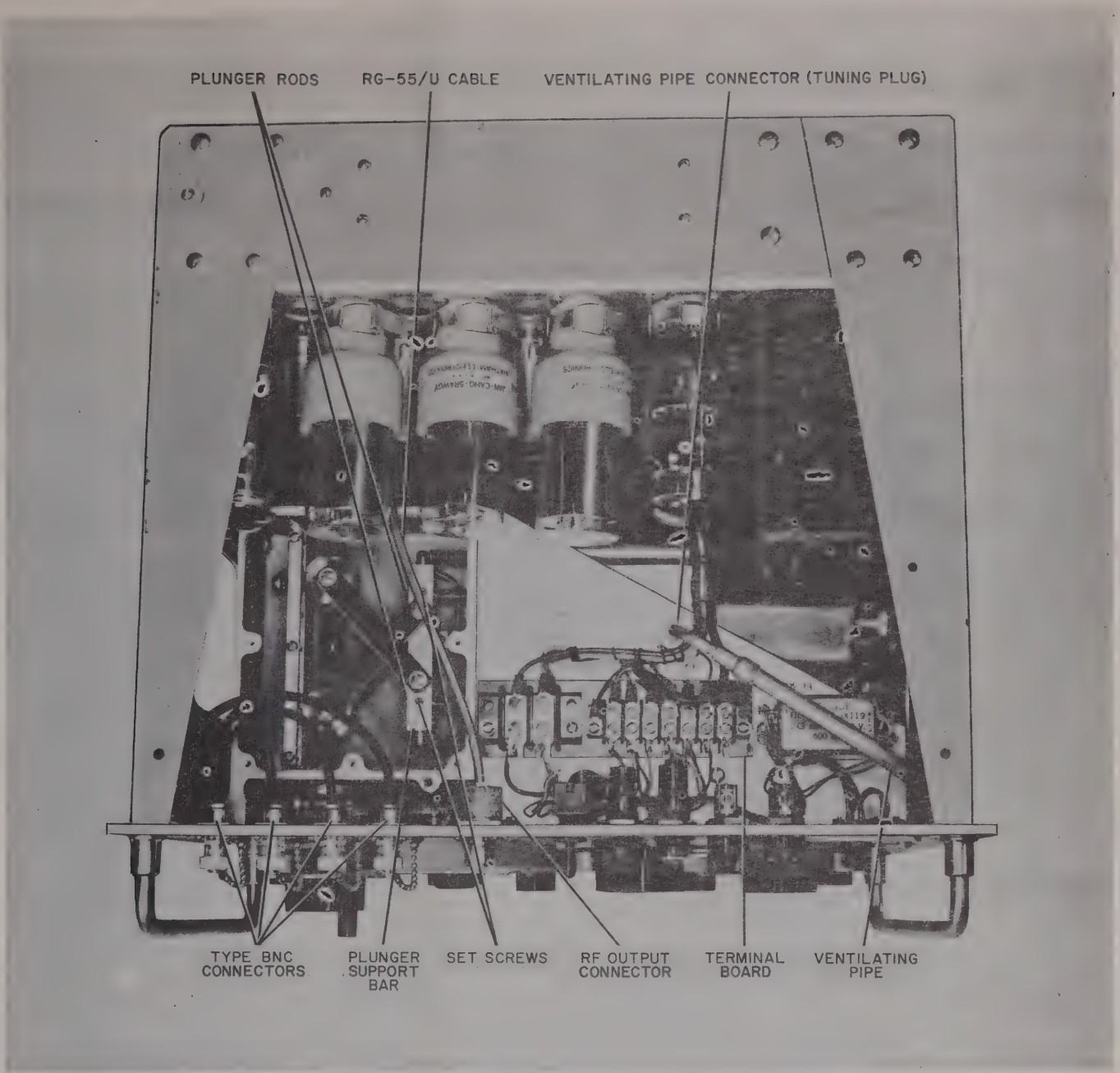


Figure 6-8A. Frequency Control Assembly, AN/URM-52A, Bottom View

6-27. REMOVING POWER MONITORING PROBE ASSEMBLY. (See figures 6-8 and 6-10.) The power level within the resonator is sampled by an assembly consisting of the power monitoring probe, an open bead type thermistor at its tip, and the probe mounting block and terminals. The assembly will normally last the life of the equipment. However, in the event that replacement becomes necessary, the following procedure should be employed:

a. Remove attenuator probe assembly in accordance with the procedure in paragraph 6-26.

b. Disconnect the fine black and white leads that are soldered to the terminals on the power monitoring probe mounting block (figure 6-8).

c. Remove screw holding power monitoring mounting block to end of power monitoring probe rack gear (figure 6-10).

d. Withdraw probe from circular waveguide housing (figure 6-8).

6-28. REPLACING POWER MONITORING PROBE ASSEMBLY. (See figure 6-8 and 6-10.) The power monitoring probe assembly is replaced in accordance with the following procedure:

a. Insert new probe only as far as is necessary to line up mounting holes (figure 6-8). It is important that the replacement probe is not inserted too far into the waveguide housing (figure 6-8).

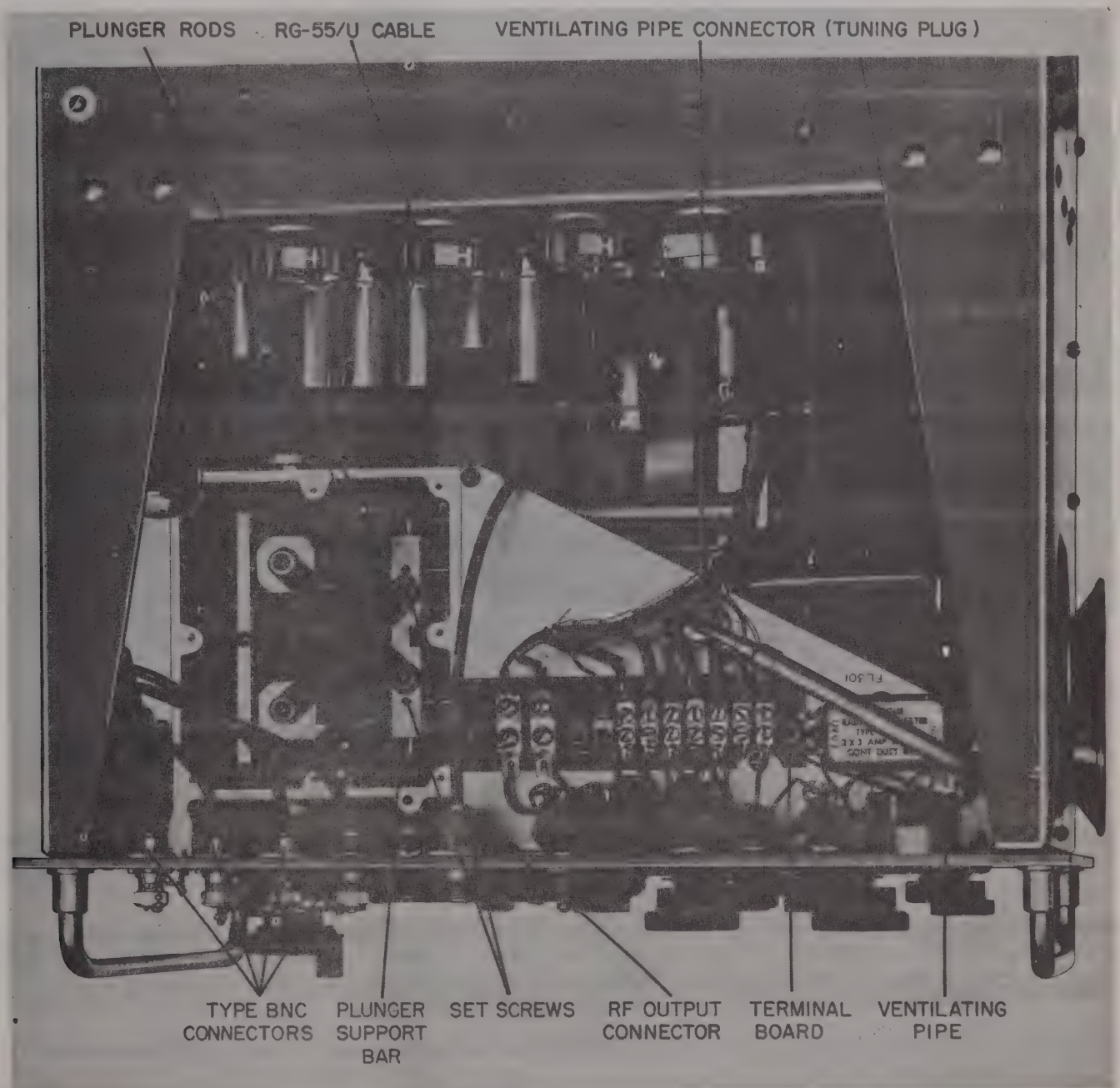


Figure 6-9. Frequency Control Assembly, AN/URM-52, Bottom View

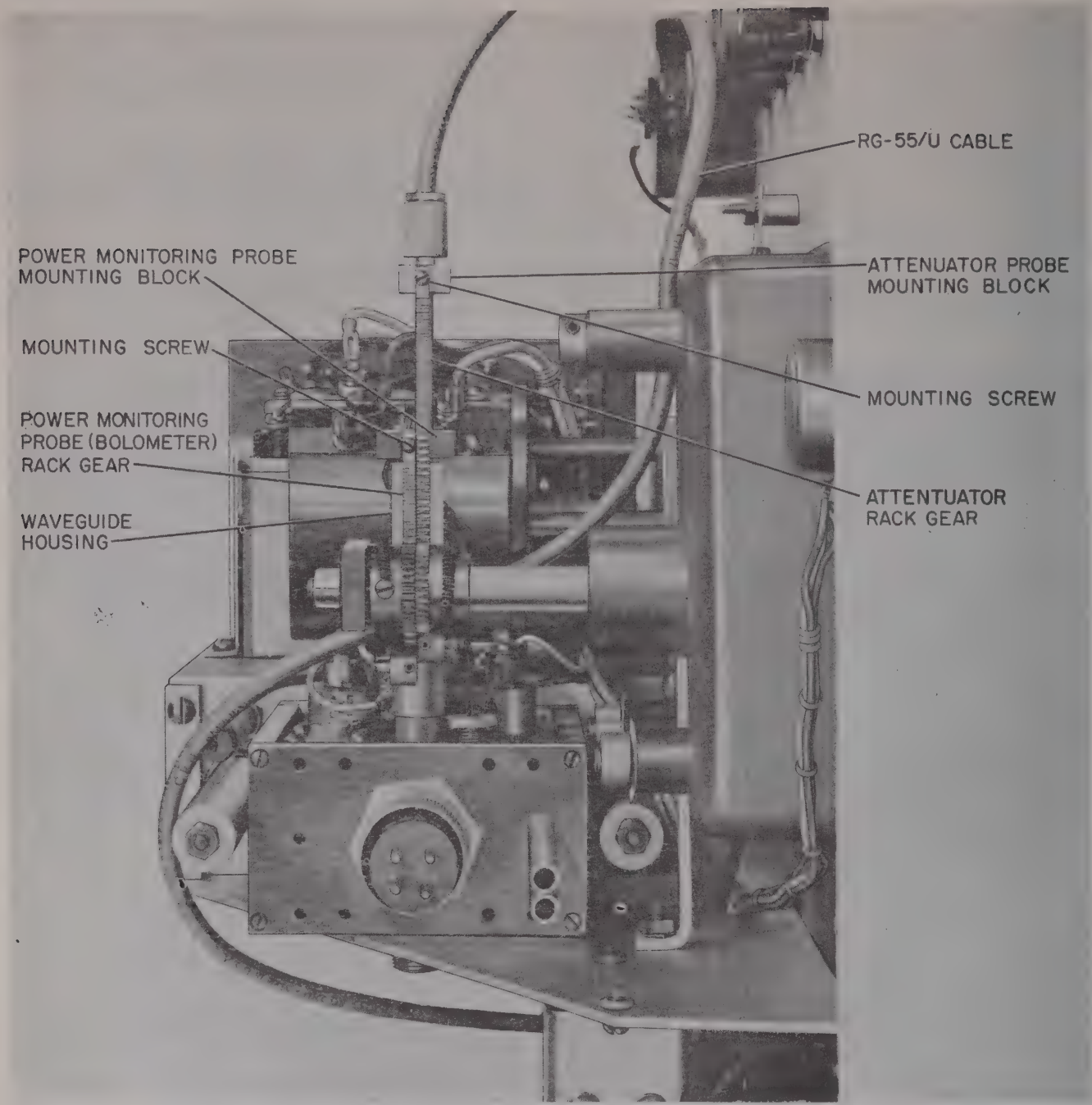


Figure 6-10. Attenuator and Power Monitoring Probe Drive Assembly

b. Install mounting screw and tighten (figure 6-10).

c. Solder black lead to terminal which is connected to shell of probe (figure 6-8).

d. Solder white lead to terminal which is connected to the center conductor of the probe (figure 6-8).

e. Install attenuator probe assembly in accordance with procedure in paragraph 6-29.

f. Upon installation of a new power monitoring probe, the calibration of the attenuator dial will usually be inaccurate, necessitating recalibration of this dial in accordance with paragraph 6-30.

6-29. REPLACING ATTENUATOR PROBE ASSEMBLY. (See figures 6-8 and 6-10.) The attenuator probe assembly is replaced in accordance with the following procedure:

a. Insert new probe into the waveguide housing only as far as is necessary to match up the mounting holes (figure 6-8).

b. Insert mounting screw and tighten (figure 6-10).

c. Carefully thread cable under cable clamp and around casting to front panel. Avoid twisting cable more than one-quarter turn.

d. Remount RF OUTPUT connector. Tighten cable clamp.

e. After the assembly is replaced, an error of a few decibels may exist in the calibration of the attenuator dial. The calibration may be checked in accordance with the procedure in paragraph 6-30.

6-30. RECALIBRATION OF OUTPUT ATTEN. DIAL. To recalibrate OUTPUT ATTEN dial, proceed as follows:

a. Connect the equipment as shown in figure 6-11. Turn on the signal generator and allow to warm up for at least twenty minutes with the MOD. SELECTOR switch on CW.

b. Place the MOD. SELECTOR switch on OFF.

c. Adjust ZERO SET control so that needle of POWER SET meter is on ZERO SET line. Also adjust the zero set control on the 430B Power Meter for zero meter reading. These adjustments should be made as quickly as possible (10 to 15 seconds) to reduce drift due to ambient temperature change.

d. Place MOD. SELECTOR switch to CW.

e. Tune signal generator to 3000 megacycles.

f. Adjust POWER SET control so that POWER SET meter indicates 0 DBM (red line at midscale).

g. Adjust the Detector Mount G485B for maximum indication on the -5 dbm range of the 430 Power Meter.

h. Adjust OUTPUT ATTEN. control to give -7 output.

i. Record the indication of the 430 Power Meter.

j. Repeat steps b through i for frequencies of 4000, 5000, 6000 and 7500 megacycles. The measurements should be 7 dbm ± 1-1/4 dbm at all frequencies. If they are not, proceed with step k.

k. Repeat steps b through i every 200 megacycles from 3800 to 7600 megacycles, each time using the same OUTPUT ATTEN. dial setting.

l. Plot the data recorded on a graph, dbm vs frequency.

m. Draw a curve of the data to form a response curve for the signal generator. A typical curve thus obtained should consist of a series of peaks and troughs having a maximum range of ± 1-1/4 dbm.

n. Draw a line through the curve so that the variations are averaged about the line.

o. Select a frequency where the curve intersects the average line. Tune the signal generator to this frequency.

p. Tune detector mount for maximum reading on 430B Power Meter.

q. With MOD. SELECTOR switch on OFF, zero set both meters.

r. With MOD. SELECTOR switch on CW, adjust POWER LEVEL meter to 0 dbm.

s. Adjust OUTPUT ATTEN. control until 430B POWER METER indicates -7 dbm. Lock Control.

t. Remove cover plate, loosen the set screws holding attenuator dial to shaft and slip dial to make it indicate -7 dbm. Tighten set screws and replace cover plate.

u. The adjustment is complete when the Power Meter reads -7 dbm and the OUTPUT ATTEN. dial indicates -7 dbm when the signal generator is tuned to the frequency determined by steps k through n.

6-31. REMOVING REPELLER TRACKING POTENTIOMETER R-174. (See figures 6-8, 6-8A, 6-9, 6-13 & 6-13A.) To remove repeller tracking potentiometer R-174 requires the removal of the front panel assembly. This will require removal of the four type BNC connectors from the front panel, all panel leads connected to the terminal board under the cavity (figure 6-8A or 6-9), and the klystron housing and socket (figure 6-8). The panel assembly can then be safely drawn away from the rest of the instrument. Following removal of the panel assembly, proceed as follows:

a. Loosen the set screws holding potentiometer R-174 shaft in the coupler (figures 6-13 and 6-13A). Remove leads from potentiometer and tag for easy identification on replacement.

b. Remove the three screws holding the potentiometer to the mounting ring and withdraw potentiometer.

6-32. REPLACING REPELLER TRACKING POTENTIOMETER R-174. (See figures 6-8, 6-8A, 6-9, 6-13 and 6-13A.) To replace potentiometer R-174, proceed as follows:

a. Place the shaft of the new potentiometer in the coupler (figures 6-13 and 6-13A). Do not tighten the set screws.

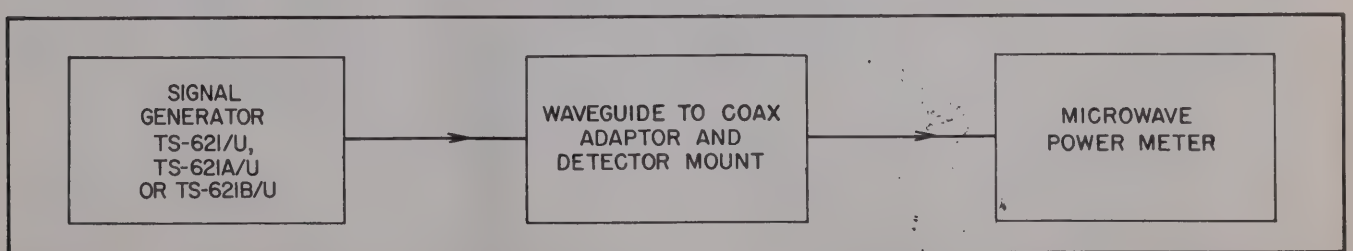


Figure 6-11. Block Diagram of Test Setup for Measurement of Power Output and Calibration of Attenuator Dial

b. Position potentiometer with terminals near the top and replace the three mounting screws. Use care so that potentiometer shaft does not bind in coupler during any portion of rotation. Tighten mounting screws. Replace leads to respective terminals on the potentiometer.

c. Turn SIGNAL FREQUENCY control to one-half turn from low frequency end.

d. Adjust potentiometer arm so that it is just at the end of potentiometer resistance wire.

e. Tighten set screws in the coupler.

f. Reset repeller voltage adjustments as described in paragraph 6-24, steps f through o.

g. Replace panel assembly, including all items removed in paragraph 6-31 (figures 6-8 and 6-9).

6-33. CHECKING AND RECALIBRATING PULSE RATE CONTROL. (Figure 6-12). Proceed as follows:

a. Synchronize oscilloscope from SYNC. OUT connector.

b. Connect DELAYED SYNC. OUT connector to oscilloscope vertical input.

c. Connect the output of a calibrated audio oscillator through a 10,000 ohm isolating resistor to oscilloscope vertical input.

d. Set SYNC. SELECTOR switch to X1 and MOD. SELECTOR switch to INT.

e. Measure the minimum and maximum repetition rates available with adjustment of PULSE RATE control. This is done at each setting of this control by adjusting audio oscillator and oscilloscope sweep until several cycles of sine wave appear on oscilloscope. Adjust audio oscillator until a pulse is superimposed at the same point on each cycle of the sine wave. Record the actual frequency as indicated by the audio oscillator dial for each setting of the PULSE RATE control.

f. Set SYNC. SELECTOR switch to X10 and repeat for minimum and maximum settings of the PULSE RATE control. The minimum pulse frequency with the SYNC. SELECTOR switch on X1 should be no greater than 40 pps, the maximum pulse frequency with the SYNC. SELECTOR switch on X10 should be at least 4000 pps, and the two ranges should overlap. If these limits are not met, proceed with steps g through p.

g. With SYNC. SELECTOR switch on X10 set PULSE RATE control to 400, thus giving rate of 4000 pps.

h. Adjust audio oscillator to 4000 pps.

i. Adjust oscilloscope sweep rate so that several cycles of sine wave occupy the full width of the screen.

j. Adjust R-112 (figure 6-13 or 6-13A) so that the generated pulse rate is 4000 pps. When the repetition rate of the pulses is 4000 pps, each pulse will be superimposed upon each cycle of sine wave. Adjust R-112 until the pattern is stationary and all slope is removed (top of pulses in a straight, horizontal line).

k. Set SYNC. SELECTOR switch to X1, with the other controls remaining unchanged. Adjust audio oscillator to 400 cps.

l. Adjust R-113 (figure 6-13 or 6-13A) so that the generated pulse rate is 400 pps.

m. Set PULSE RATE control to 40 pps, with the other controls remaining unchanged. Adjust audio oscillator to 40 cps.

n. Adjust R-117 (figure 6-13 or 6-13A) so that the generated pulse rate is 40 pps.

o. Set the SYNC. SELECTOR switch to X10 position and check the calibration of PULSE RATE control in the vicinity of 40. R-117 can be readjusted to improve the calibration accuracy if desired.

p. Repeat the complete procedure, making any desired refinements in adjustments.

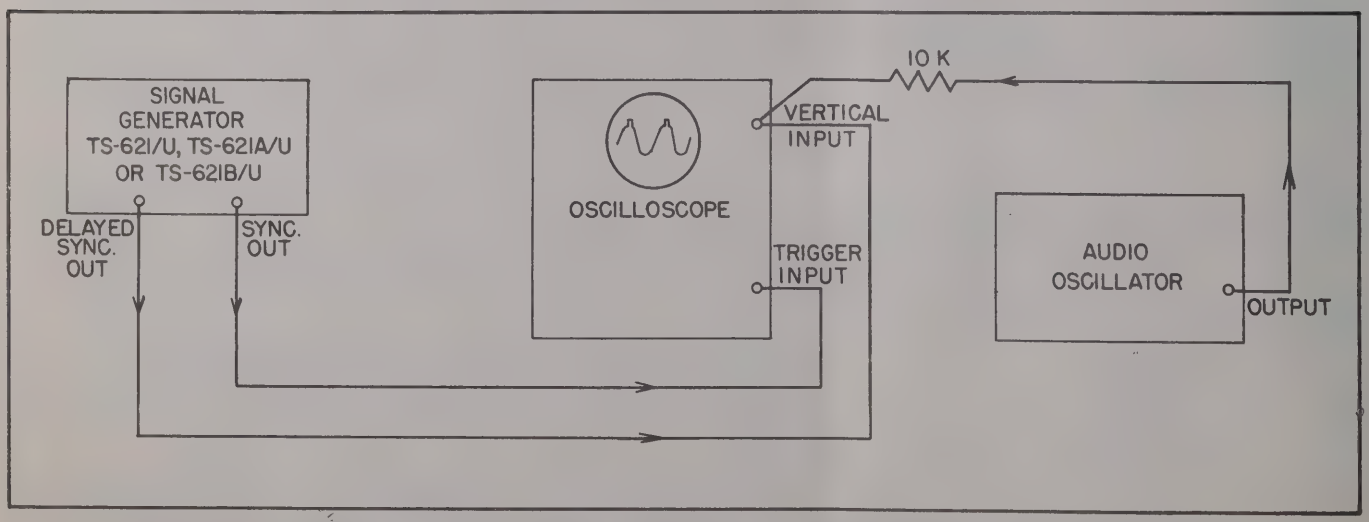


Figure 6-12. Block Diagram of Test Setup for Checking and Recalibrating Pulse Rate Control

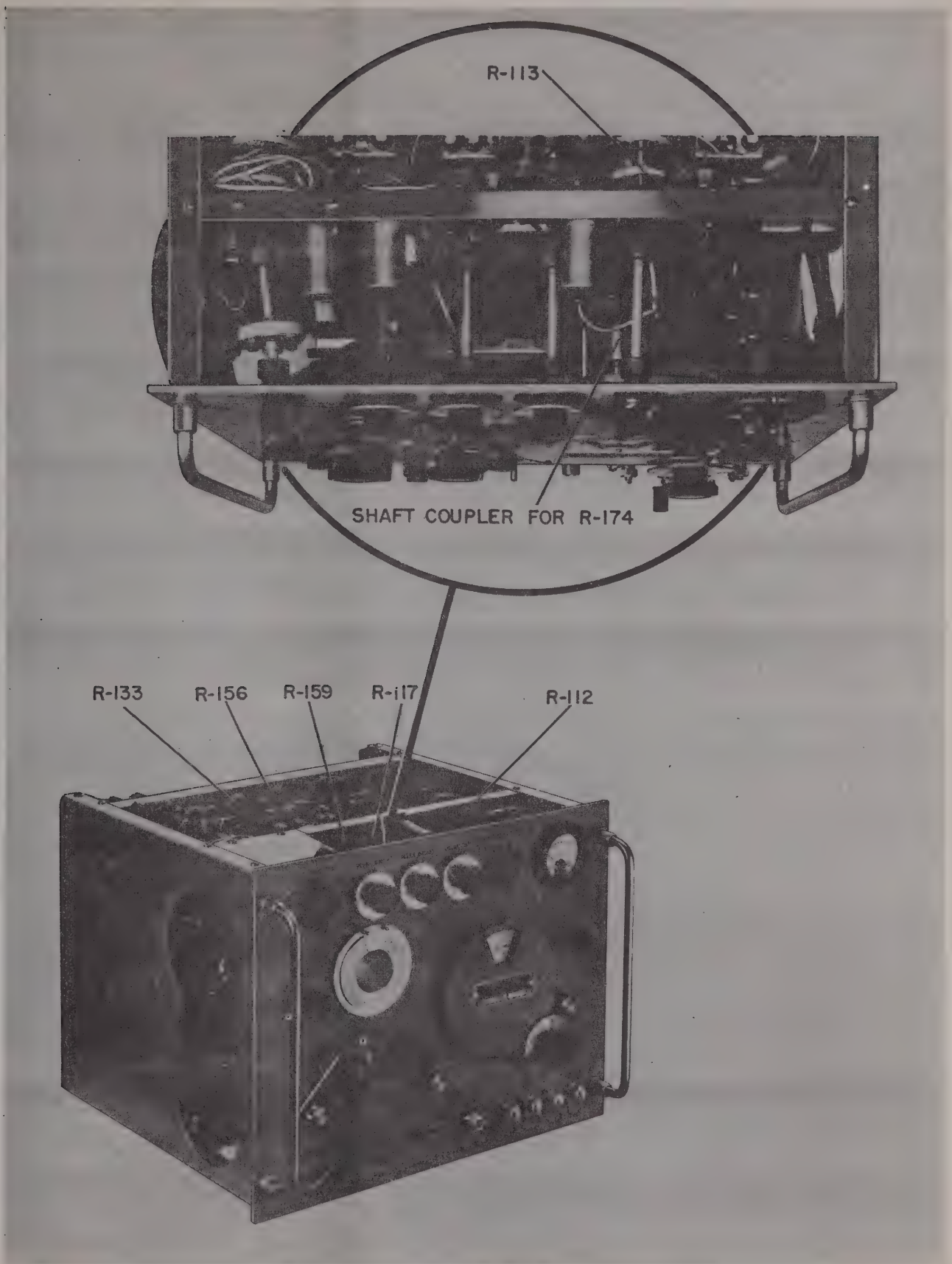


Figure 6-13. Location of Internal Controls, AN/URM-52, Pulser

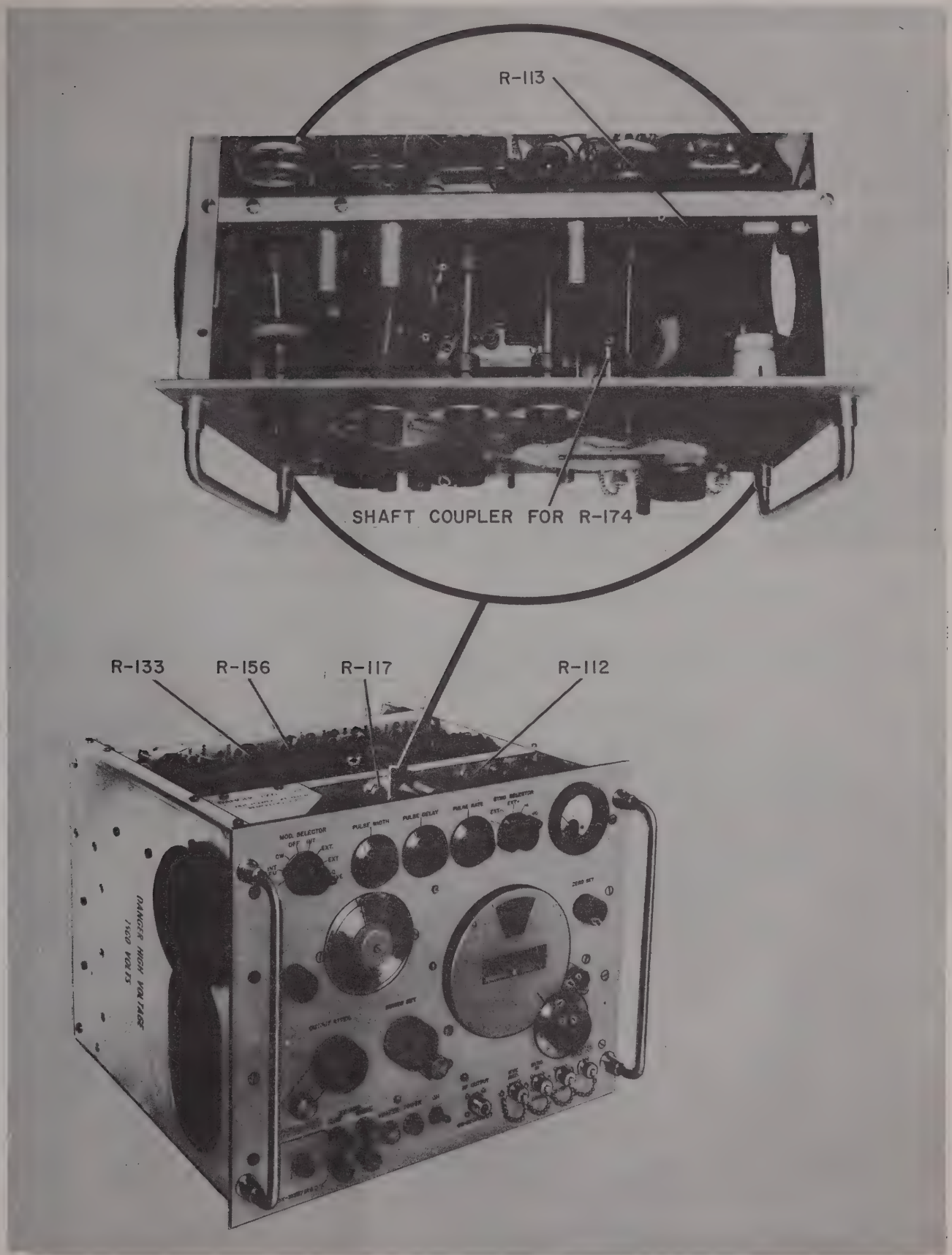


Figure 6-13A. Location of Internal Controls, AN/URM-52A, Pulser

6-34. CHECKING AND CALIBRATING PULSE DELAY CONTROL. (See figure 6-14.) Proceed as follows:

a. Connect RF OUTPUT connector through the crystal detector to the vertical input of an oscilloscope having an accurately calibrated sweep.

b. Synchronize oscilloscope from SYNC. OUT connector and set sweep length of oscilloscope convenient for observing the delay period being measured.

c. Set MOD. SELECTOR switch to INT.

d. Check the minimum and maximum delay obtainable with adjustments of PULSE DELAY control by comparing the amount of delay with the calibrated sweep length of the oscilloscope. The minimum should be no greater than 3 microseconds and the maximum should be at least 300 microseconds. If these limits are not obtained, proceed with steps e through i.

e. Set PULSE DELAY control to maximum.

f. Adjust R-133 (figure 6-13 or 6-13A) to give a delay of 350 microseconds. The delay is indicated by the interval between the start of the oscilloscope trace and the leading edge of the rectified r-f pulse appearing on the oscilloscope.

g. Adjust R-156 (figure 6-13 or 6-13A) to give pulse width of 10.5 microseconds.

h. Readjust R-133 (figure 6-13) to bring 300 microseconds delay on calibration.

i. Repeat steps g and h for best overall calibration.

6-35. CHECKING PULSE SHAPE OF RF OUTPUT PULSE. (See figure 6-14.) Pulse shape includes such factors as pulse width, rise and decay time, and flatness of top. Proceed as follows:

a. Connect test equipment as described in paragraph 6-34, steps a and b, adjust the sweep length of the oscilloscope convenient for observing the pulse width being measured.

b. Adjust SIGNAL FREQUENCY control to mid range.

c. Set MOD. SELECTOR switch to INT.

d. Set PULSE DELAY control to 3. On the AN/URM-52A, set R352 to its mid-range position.

e. Measure the minimum and maximum pulse widths available with adjustment of PULSE WIDTH control by comparing the time occupied by the pulse with the known total sweep time. The minimum pulse width should be no more than 0.5 microseconds and the maximum should be at least 10 microseconds. If these limits are not obtained, proceed with steps f through l, before going on the step m. Otherwise, go right ahead to step m.

f. Adjust SIGNAL FREQUENCY control to frequency giving shortest width of pulse with PULSE WIDTH control set to maximum.

g. Adjust R-156 (figure 6-13) to give pulse width of 10.5 microseconds.

h. Adjust SIGNAL FREQUENCY control to frequency giving longest width of pulse with PULSE WIDTH control set to minimum.

i. On the TS-612/U, adjust R-159 (figure 6-13) to give pulse width of 0.25 microsecond.

j. Repeat steps f through i.

k. Tune signal generator to a frequency giving an average of the minimum and maximum pulse widths for a given setting of PULSE WIDTH control.

l. Slip PULSE WIDTH control to bring control into calibration at approximately its middle setting, and make minor adjustments on R-156, for maximum and R-159 (TS-621/U only) for minimum width, for best overall calibration.

m. Set oscilloscope calibrated sweep to 2 microseconds.

n. Set PULSE DELAY control to 0.

o. Set PULSE WIDTH control to approximately 1.

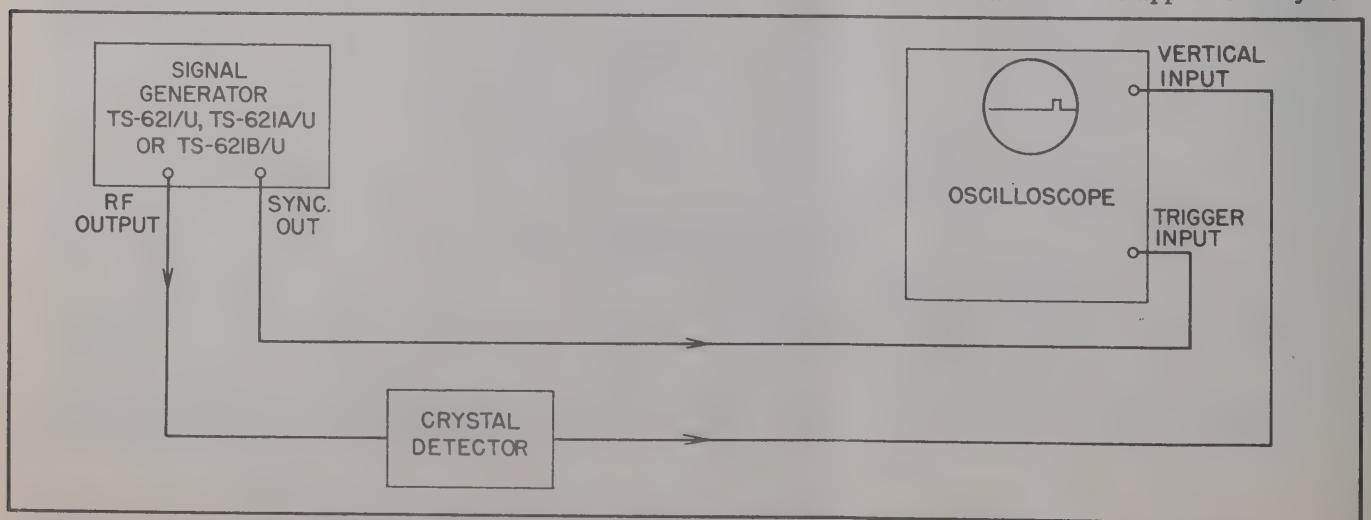


Figure 6-14. Block Diagram of Test Setup for Checking Pulse Delay and Pulse Shape of RF OUTPUT Pulse

p. Measure the rise and decay time by comparison with the total oscilloscope sweep length of 2 microseconds. The combined rise and decay time should not be greater than 0.5 microseconds when measured between points that are 10 percent and 90 percent of the initial rise and final decay.

q. Set oscilloscope sweep length to approximately 20 microseconds.

r. Vary PULSE WIDTH control over its range and observe the flatness on the top of the pulse. The envelope of the pulse should have essentially a flat top between points on the initial rise and final decay that are 90 percent of the maximum amplitude of the initial rise. The amplitude of the envelope should be within 90 to 100 percent of the maximum amplitude of the initial rise. The final decay should have no rise in excess of 10 percent of the maximum of the initial rise. On the AN/URM-52A, adjust R352 for optimum characteristics of the pulse shape as displayed on the oscilloscope.

s. Repeat step l and steps m through r at frequencies near minimum and maximum of the r-f range.

6-36. REPLACING CABINET. The cabinet is replaced in accordance with instructions under paragraph 5-28.

6-37. LUBRICATION. (See paragraph 5-22.)

6-38. INSPECTION AND CLEANING SCHEDULE. (See paragraph 5-24.)

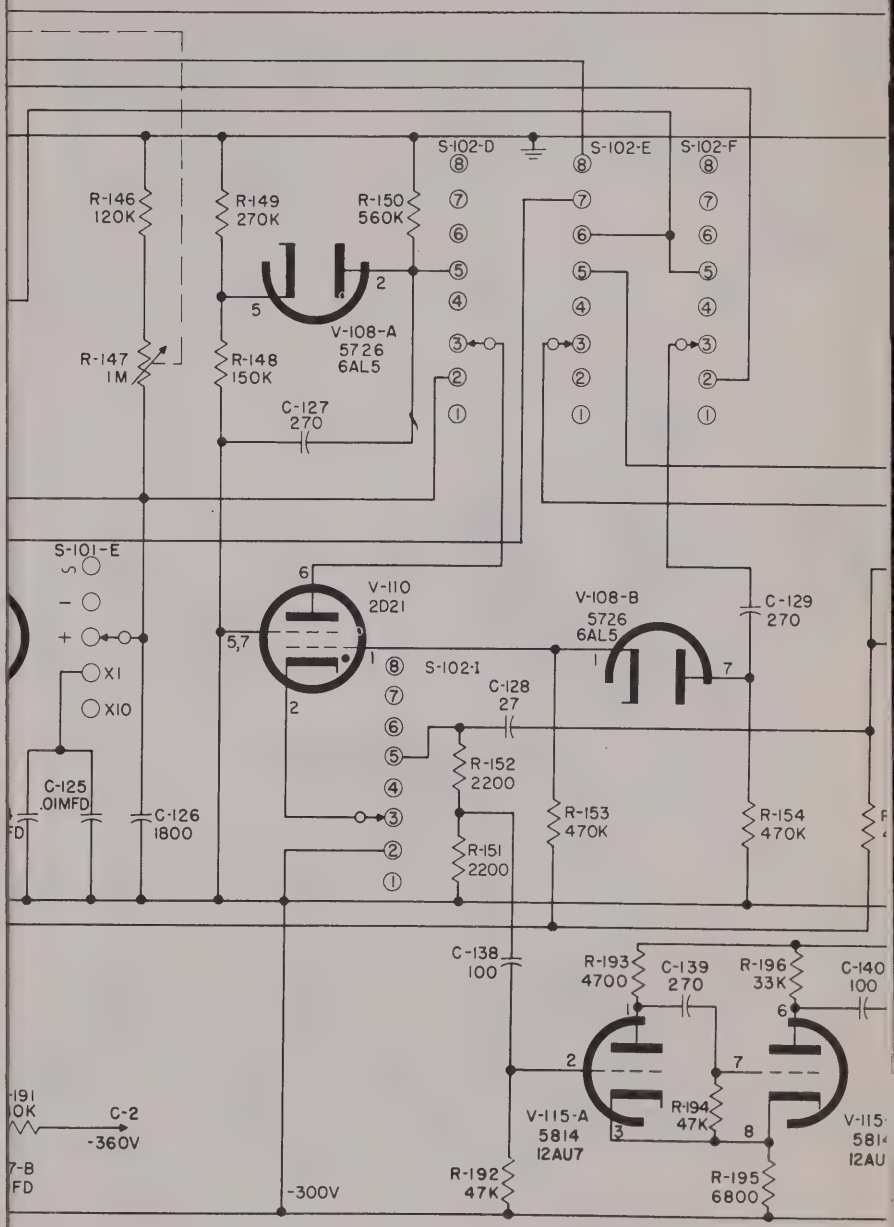
6-39. OVERHAUL SCHEDULE.

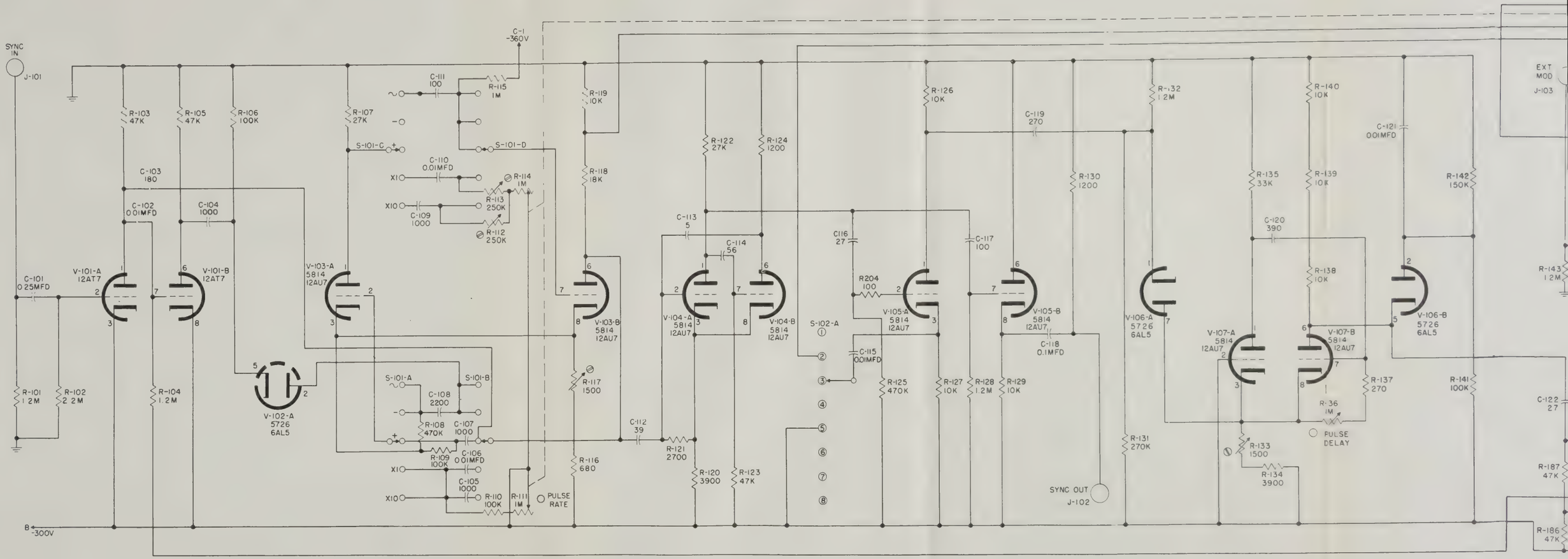
6-40. No overhaul schedule has been assigned to this equipment.

6-41. MOD. SELECTOR AND SYNC. SELECTOR SWITCHES. The representations of the MOD. SELECTOR AND SYNC SELECTOR switches on the schematic diagrams are explanations of their basic functions. Actually the switches are mechanically greatly simplified, such that circuit tracing through them without a pictorial diagram would be very difficult. To assist with circuit tracing or trouble shooting within the switch assemblies refer to figure 7-6 and figure 7-7.

SECTION VII

WIRING DIAGRAMS

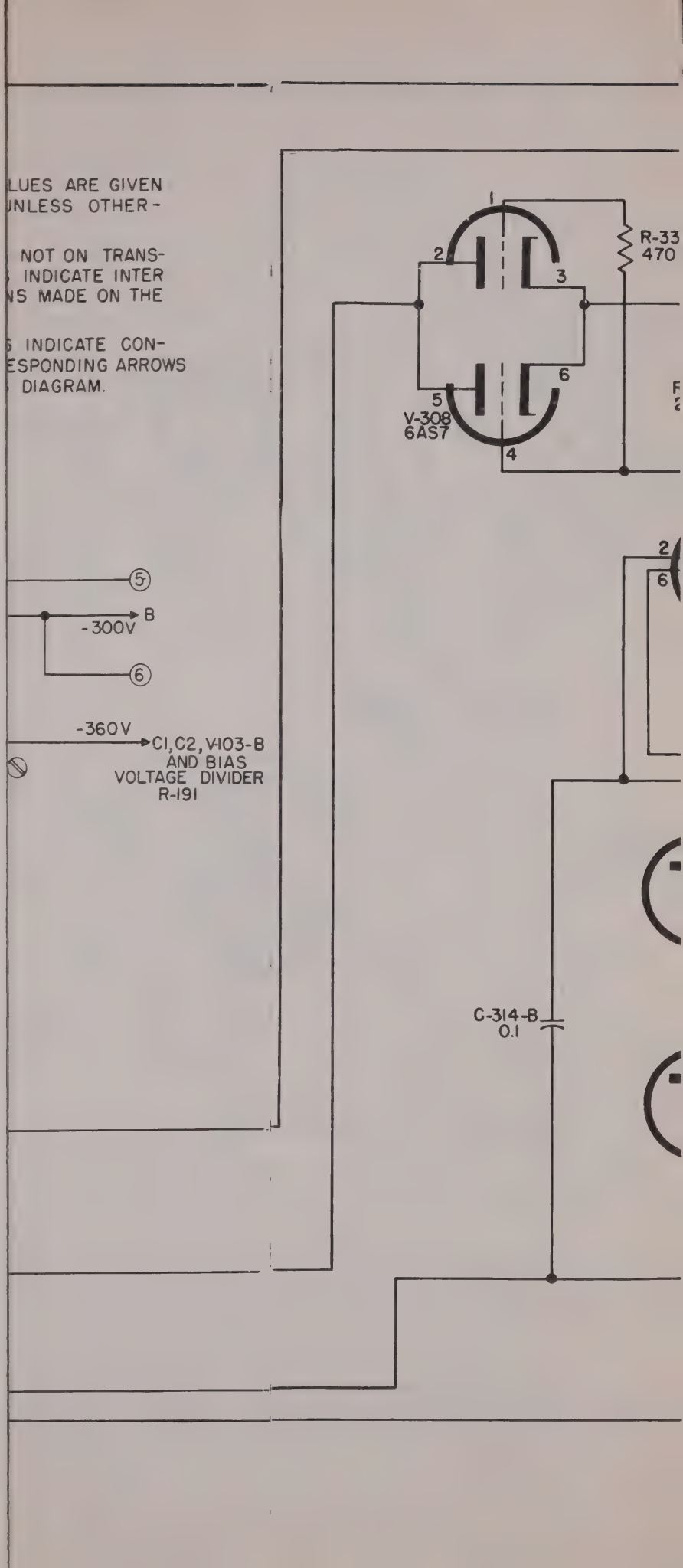

S-102-D
S-102-E
S-102-F
R-146 120K
R-149 270K
R-150 560K
V-108-A 5726 6AL5
R-147 1M
R-148 150K
C-127 270
S-101-E
V-110 2D21
V-108-B 5726 6AL5
C-129 270
S-102-1
C-128 27
R-152 2200
R-151 2200
R-153 470K
R-154 470K
C-125 .01MFD
C-126 1800
X1
X10
C-138 100
R-193 4700
C-139 270
R-196 33K
C-140 100
V-115-A 5814 12AU7
R-194 47K
R-192 47K
R-195 6800
C-2
-360V
-300V


SYNC IN
J-101
C-1 -360V
R-103 47K
R-105 47K
R-106 100K
R-107 27K
C-111 100
R-115 1M
S-101-C
S-101-D
R-119 10K
R-118 18K
C-110 0.01MFD
X1
X10
C-109 1000
R-114 1M
R-113 250K
R-112 250K
C-103 180
C-102 0.01MFD
C-104 1000
C-101 0.25MFD
V-101-A 12AT7
V-101-B 12AT7
V-103-A 5814 12AU7
V-103-B 5814 12AU7
R-101 1.2M
R-102 2.2M
R-104 1.2M
V-102-A 5726 6AL5
S-101-A
S-101-B
C-108 2200
R-108 470K
C-107 1000
R-109 100K
C-106 0.01MFD
C-105 1000
R-110 100K
R-111 1M
PULSE RATE
R-117 1500
R-116 680
C-112 39
R-121 2700
R-120 3900
R-123 47K
R-122 27K
R-124 1200
C-113 5
C-114 56
V-104-A 5814 12AU7
V-104-B 5814 12AU7
R-126 10K
C116 27
C-117 100
R204 100
V-105-A 5814 12AU7
V-105-B 5814 12AU7
C-118 0.1MFD
C-115 .001MFD
R-125 470K
R-127 10K
R-128 1.2M
R-129 10K
S-102-A
SYNC OUT J-102
R-130 1200
R-131 270K
R-132 1.2M
C-119 270
V-106-A 5726 6AL5
R-135 33K
R-139 10K
R-140 10K
C-120 390
R-138 10K
V-107-A 5814 12AU7
V-107-B 5814 12AU7
R-133 1500
R-134 3900
R-136 1M
PULSE DELAY
R-137 270
C-121 .001MFD
V-106-B 5726 6AL5
R-142 150K
R-141 100K
EXT MOD J-103
R-143 1.2M
C-122 27
R-187 47K
R-186 47K
B -300V

NOTES:
1. VALUES OF CAPACITORS ARE GIVEN IN MICROMICROFARADS UNLESS OTHERWISE SPECIFIED.
2. ⊘ INTERNAL ADJUSTMENT. ○ FRONT PANEL CONTROL
3. SECOND HALF OF V-102 IS NOT USED.
4. CIRCLED NUMBERS INDICATE INTER-DECK CONNECTIONS MADE ON THE TERMINAL BOARD LOCATED BENEATH THE RESONATOR
5. LETTERED ARROWS INDICATE CONNECTIONS TO CORRESPONDING ARROWS ON ACCOMPANYING DIAGRAM

S-102 POSITION	PANEL DESIGNATION
1	EXT FM
2	INT FM
3	CW
4	OFF
5	INT
6	EXT+
7	EXT−
8	SQ WAVE

Figure 7-1. Schematic Wiring Diagram of the Pulser and R-F Oscillator Sections of Signal Generator AN/URM-52.
Revised 15 December 1957


LUES ARE GIVEN
UNLESS OTHER-
NOT ON TRANS-
INDICATE INTER
NS MADE ON THE
INDICATE CON-
ESPONDING ARROWS
DIAGRAM.
R-33
470
V-308
6AS7
⑤
B
-300V
⑥
-360V
C1, C2, V103-B
AND BIAS
VOLTAGE DIVIDER
R-191
C-314-B
0.1

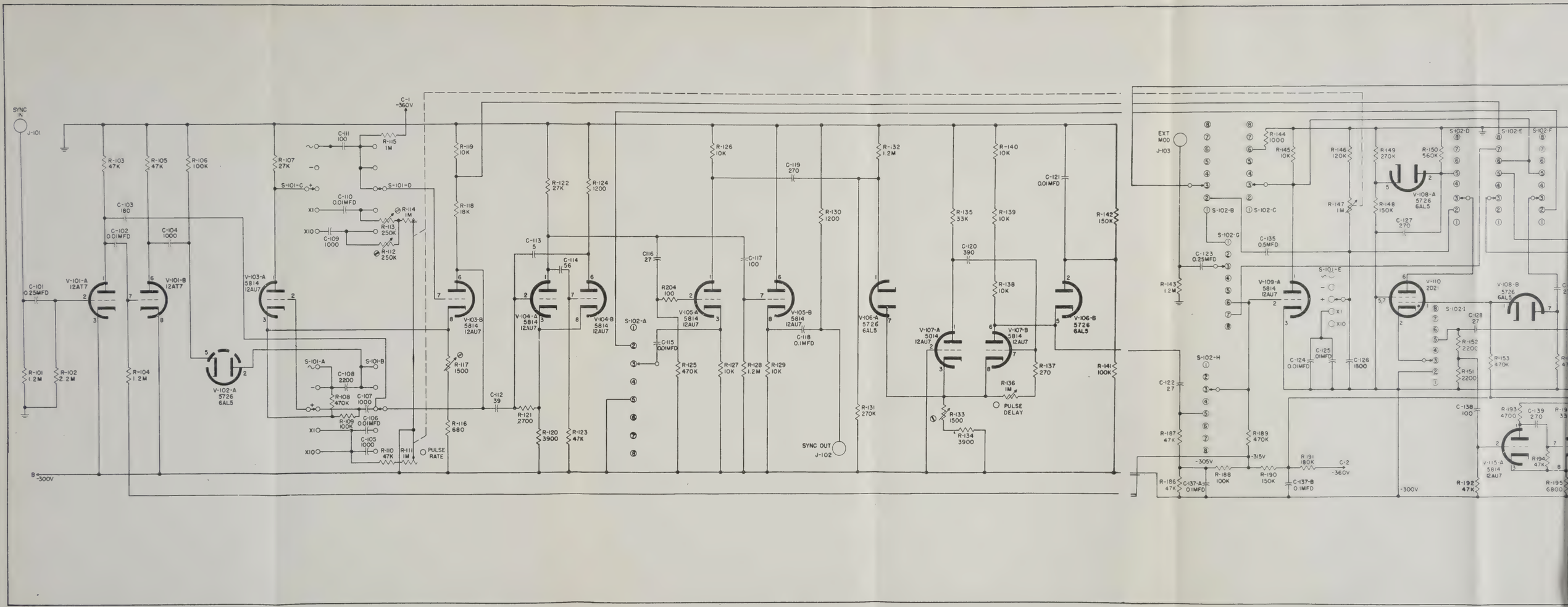
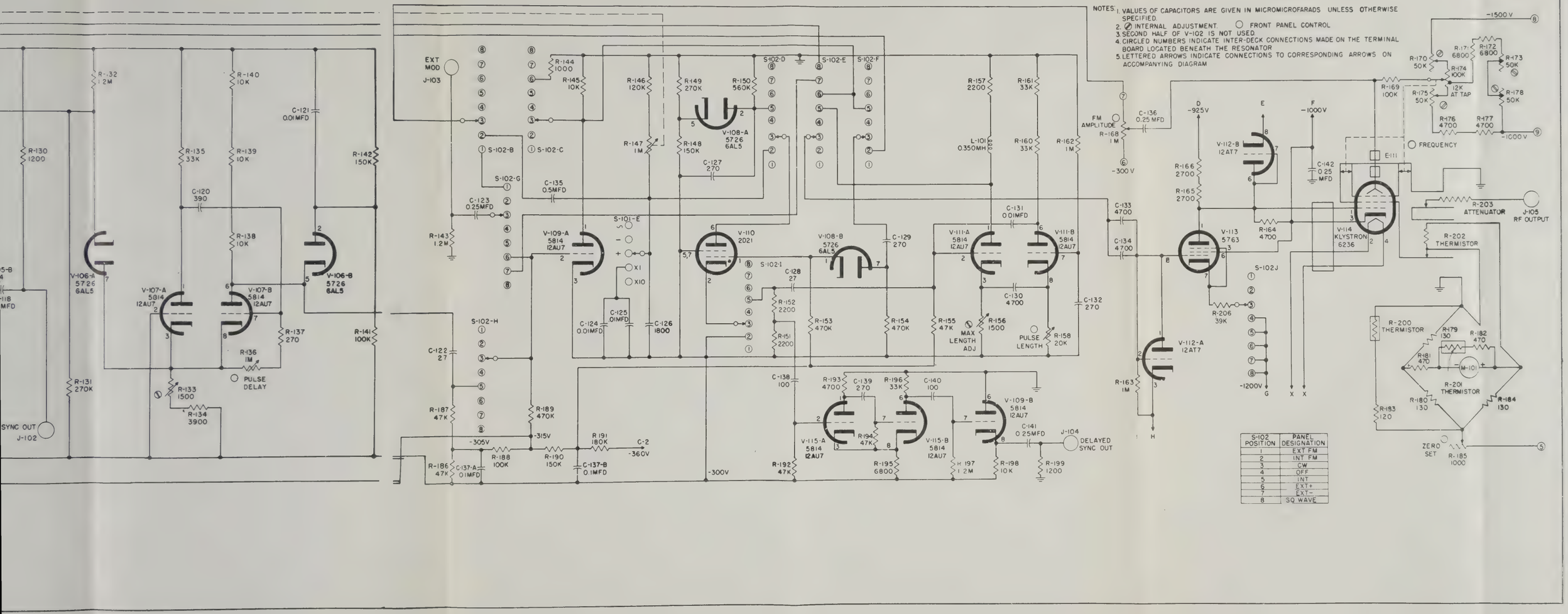
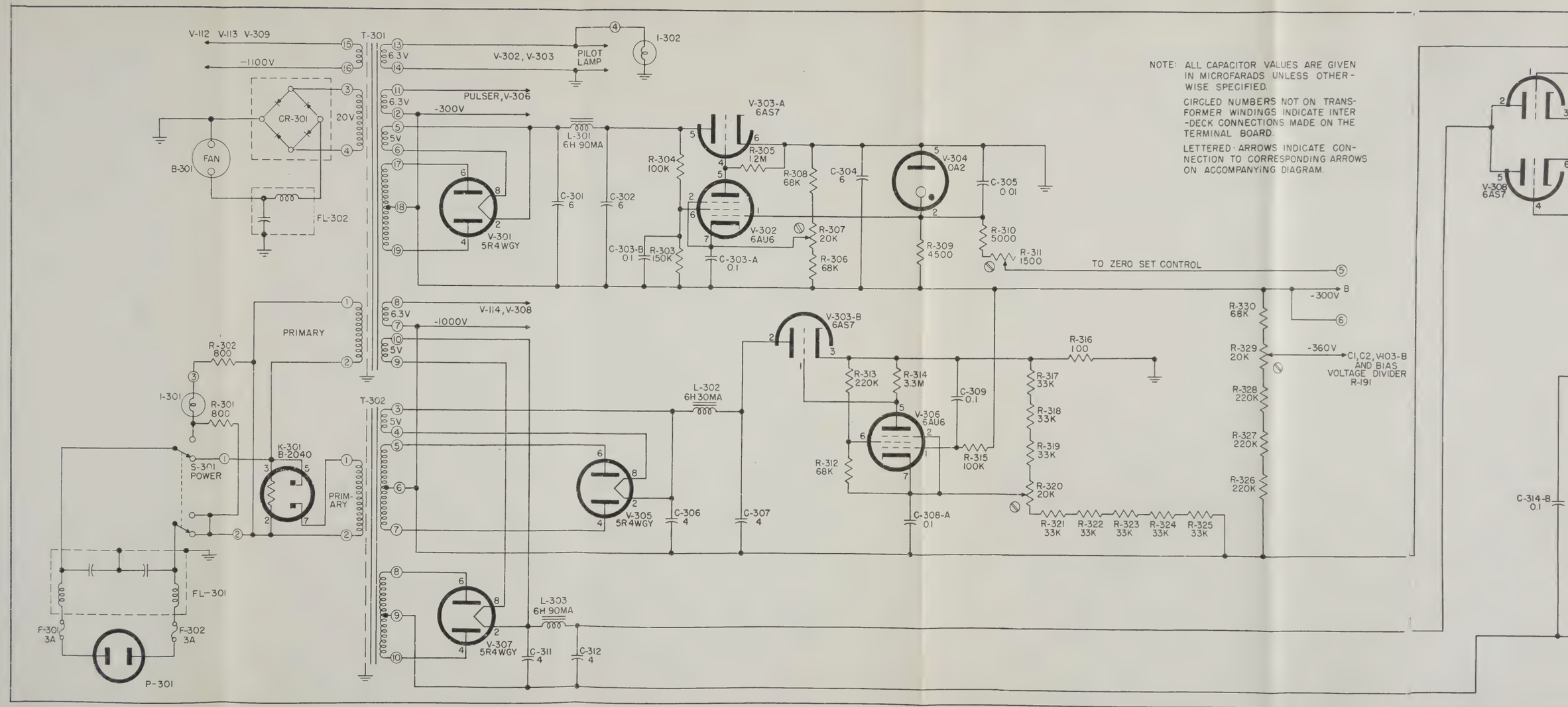


Figure 7-1A. Schematic Wiring Diagram of the Pulser and R-F Oscillator Sections of Signal Generator AN/URM-52A.

Revised 15 December 1957


NOTES:
1. VALUES OF CAPACITORS ARE GIVEN IN MICROMICROFARADS UNLESS OTHERWISE SPECIFIED.
2. ⊘ INTERNAL ADJUSTMENT. ○ FRONT PANEL CONTROL.
3. SECOND HALF OF V-102 IS NOT USED.
4. CIRCLED NUMBERS INDICATE INTER-DECK CONNECTIONS MADE ON THE TERMINAL BOARD LOCATED BENEATH THE RESONATOR.
5. LETTERED ARROWS INDICATE CONNECTIONS TO CORRESPONDING ARROWS ON ACCOMPANYING DIAGRAM
EXT MOD J-103
V-106-A 5726 6AL5
V-106-B 5726 6AL5
V-107-A 5814 12AU7
V-107-B 5814 12AU7
V-108-A 5726 6AL5
V-108-B 5726 6AL5
V-109-A 5814 12AU7
V-109-B 5814 12AU7
V-110 2021
V-111-A 5814 12AU7
V-111-B 5814 12AU7
V-112-A 12AT7
V-112-B 12AT7
V-113 5763
V-114 KLYSTRON 6236
V-115-A 5814 12AU7
V-115-B 5814 12AU7
SYNC OUT J-102
DELAYED SYNC OUT J-104
J-105 RF OUTPUT
PULSE DELAY
PULSE LENGTH
MAX LENGTH ADJ
ATTENUATOR
THERMISTOR
FREQUENCY
ZERO SET
FM AMPLITUDE
-1500 V
-1000 V
-925V
-300 V
-305V
-315V
-360V
-1200V
S-102 POSITION | PANEL DESIGNATION
1 | EXT FM
2 | INT FM
3 | CW
4 | OFF
5 | INT
6 | EXT+
7 | EXT-
8 | SQ WAVE


V-112 V-113 V-309
T-301
-1100V
CR-301
20V
B-301
FAN
FL-302
6.3V
5V
PULSER, V-306
-300V
V-302, V-303
PILOT LAMP
I-302
V-301 5R4WGY
L-301 6H 90MA
C-301 6
C-302 6
V-303-A 6AS7
R-304 100K
R-305 1.2M
R-308 68K
C-304 6
V-304 0A2
C-305 0.01
V-302 6AU6
R-307 20K
R-306 68K
R-309 4500
R-310 5000
R-311 1500
C-303-B 0.1
R-303 150K
C-303-A 0.1
TO ZERO SET CONTROL
V-114, V-308
-1000V
PRIMARY
R-302 800
I-301
R-301 800
K-301 B-2040
S-301 POWER
PRIM-ARY
T-302
L-302 6H 30MA
V-303-B 6AS7
R-316 100
R-313 220K
R-314 3.3M
C-309 0.1
V-306 6AU6
R-312 68K
R-315 100K
R-317 33K
R-318 33K
R-319 33K
R-320 20K
R-321 33K
R-322 33K
R-323 33K
R-324 33K
R-325 33K
C-308-A 0.1
R-330 68K
R-329 20K
R-328 220K
R-327 220K
R-326 220K
-360V
C1, C2, V103-B AND BIAS VOLTAGE DIVIDER R-191
V-305 5R4WGY
C-306 4
C-307 4
FL-301
F-301 3A
F-302 3A
P-301
V-307 5R4WGY
L-303 6H 90MA
C-311 4
C-312 4
NOTE: ALL CAPACITOR VALUES ARE GIVEN IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
CIRCLED NUMBERS NOT ON TRANSFORMER WINDINGS INDICATE INTER-DECK CONNECTIONS MADE ON THE TERMINAL BOARD.
LETTERED ARROWS INDICATE CONNECTION TO CORRESPONDING ARROWS ON ACCOMPANYING DIAGRAM.
V-308 6AS7
R-331 470
C-314-B 0.1

NOTE: ALL CAPACITOR VALUES ARE GIVEN IN MICROFARADS UNLESS OTHERWISE SPECIFIED.

CIRCLED NUMBERS NOT ON TRANSFORMER WINDINGS INDICATE INTER-DECK CONNECTIONS MADE ON THE TERMINAL BOARD.

LETTERED ARROWS INDICATE CONNECTION TO CORRESPONDING ARROWS ON ACCOMPANYING DIAGRAM.

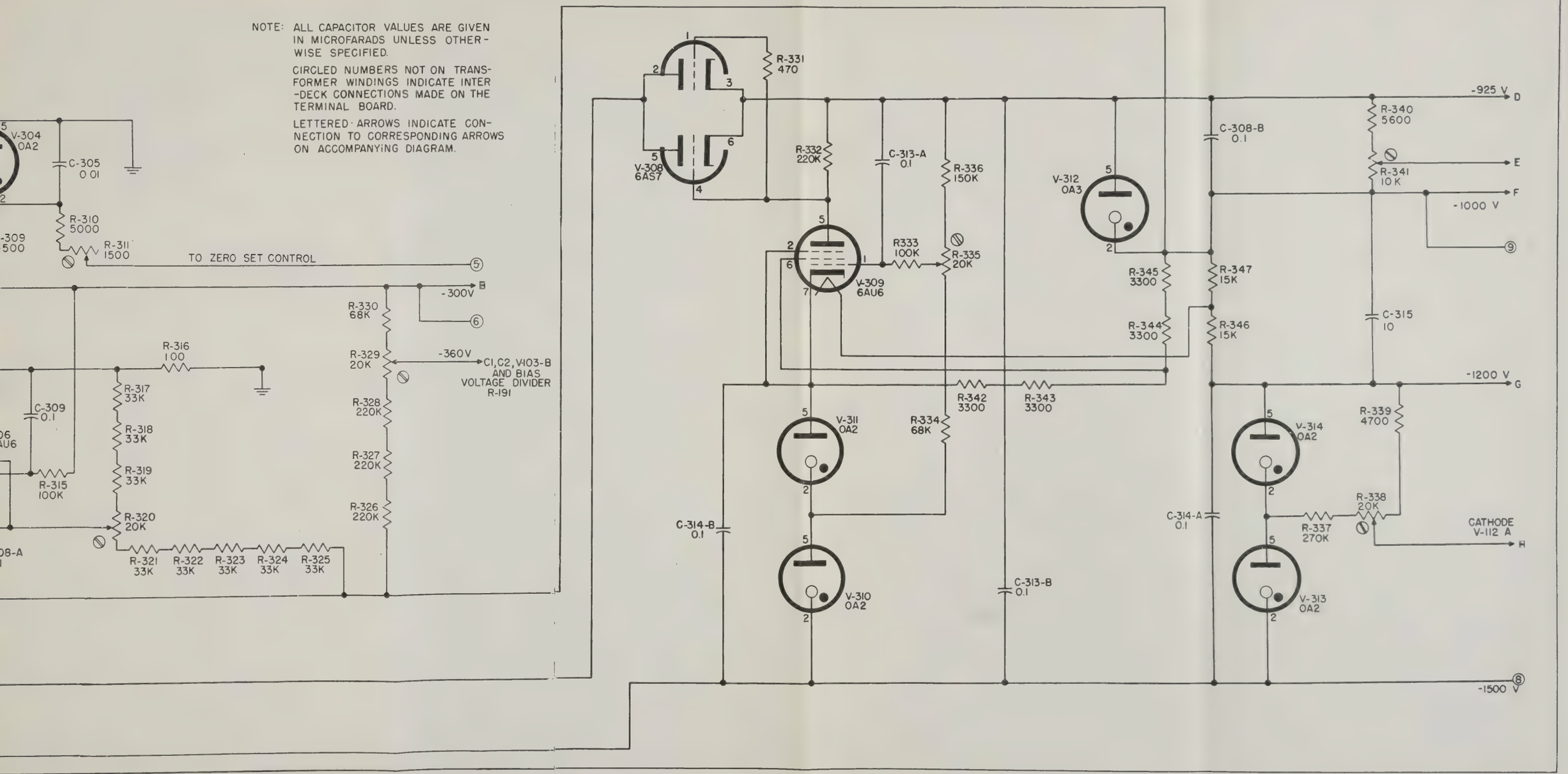
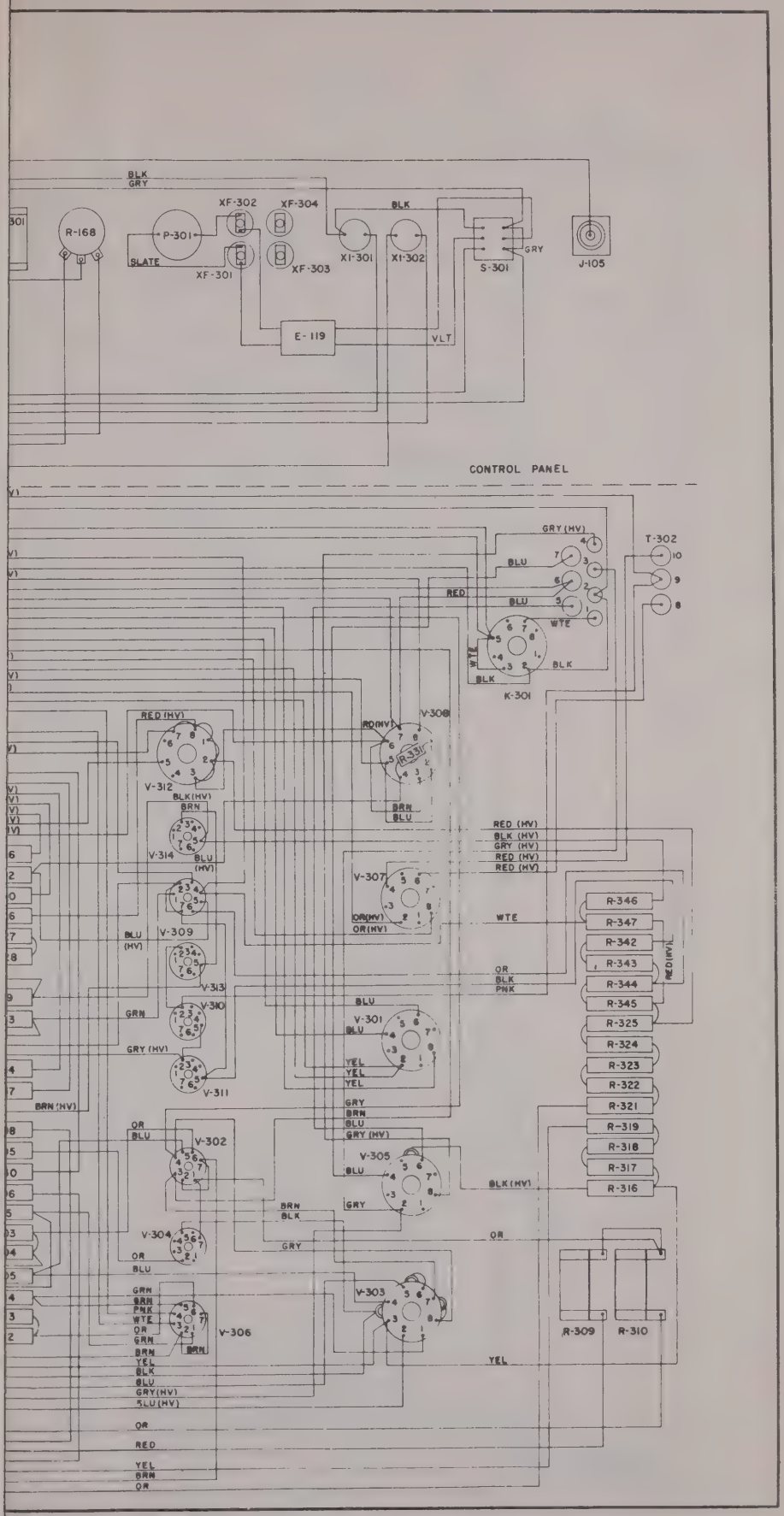


Figure 7-2. Schematic Wiring Diagram of the Power Supply Section of Signal Generator AN/URM-52.



actical Wiring Diagram Signal Generator AN/URM-52.

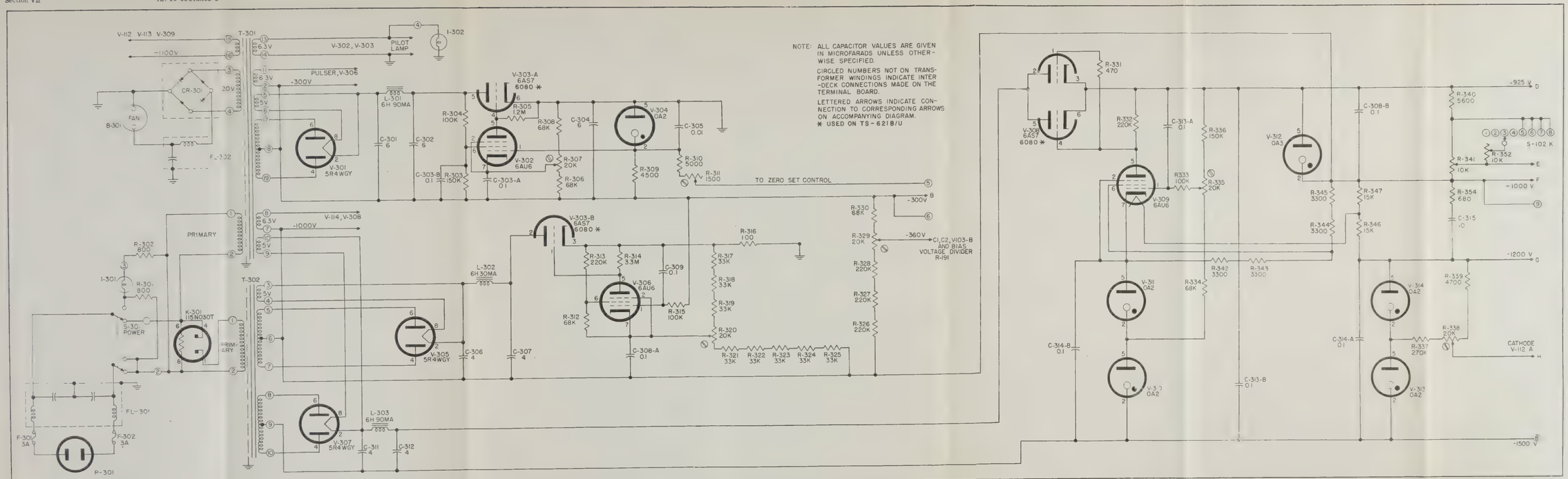


Figure 7-2A. Schematic Wiring Diagram of the Power Supply Section of Signal Generator AN/URM-52A.

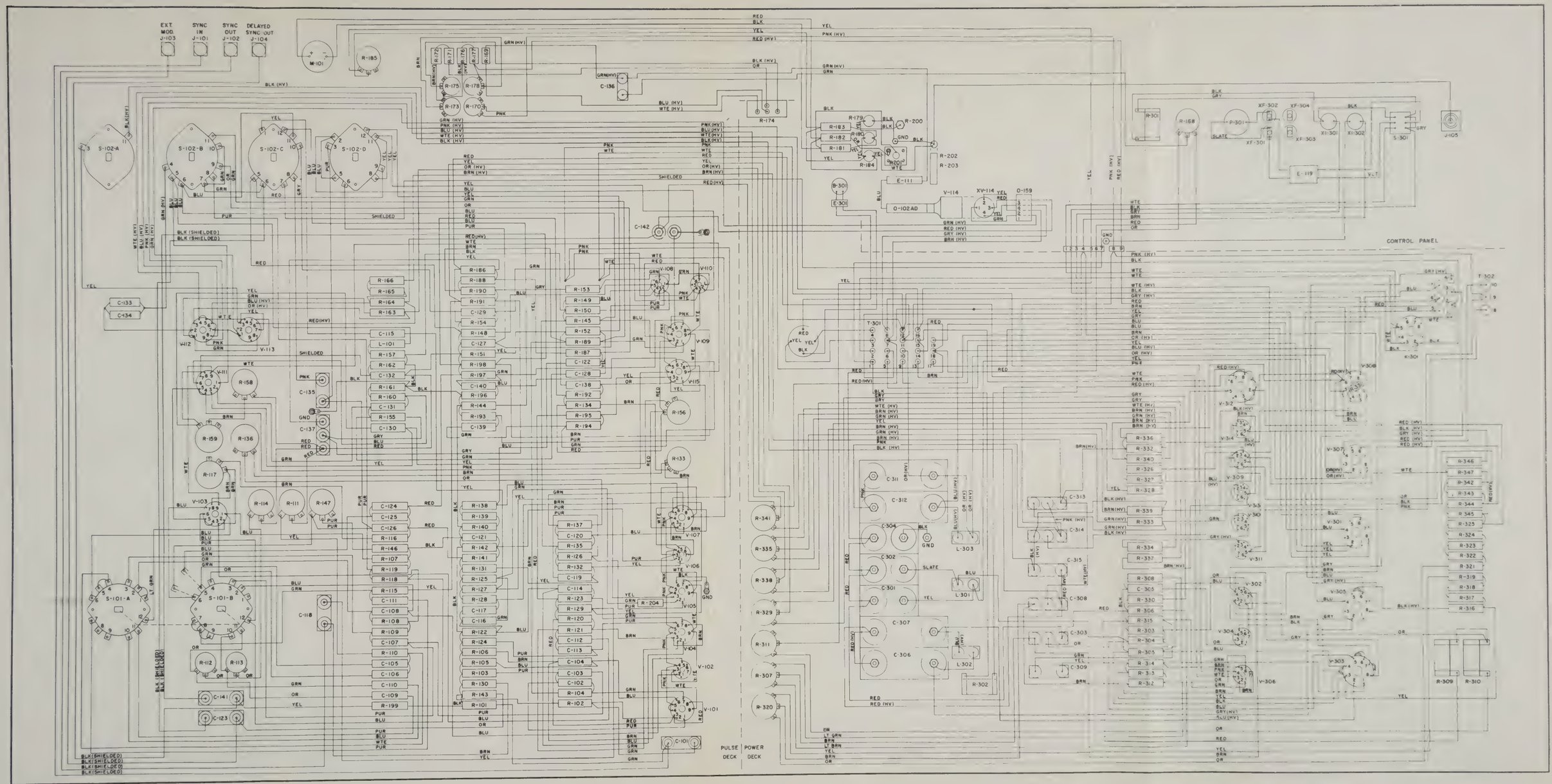


Figure 7-3. Practical Wiring Diagram Signal Generator AN/URM-52.

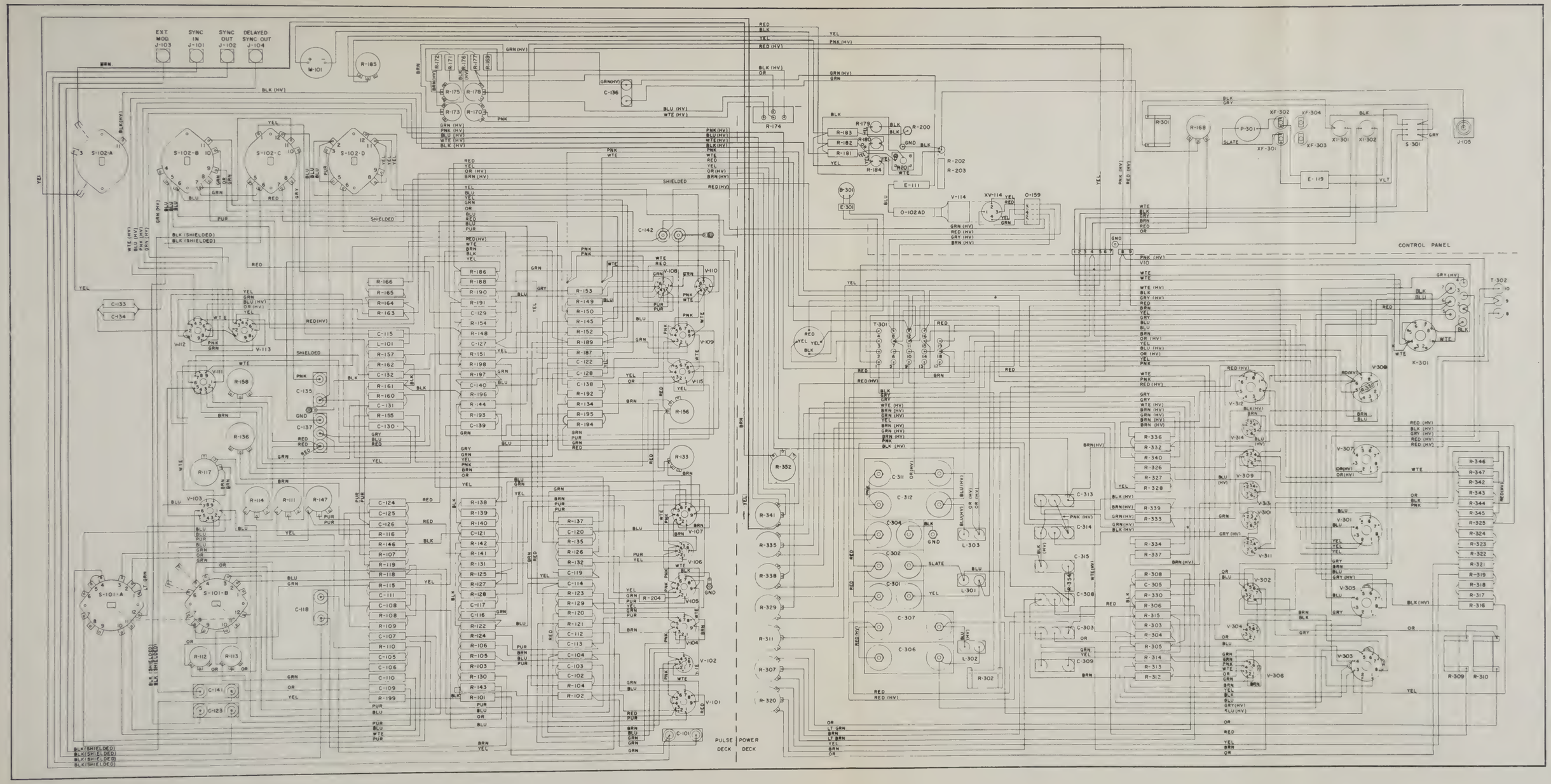


Figure 7-3A. Practical Wiring Diagram Signal Generator AN/URM-52A.

Revised 15 December 1957

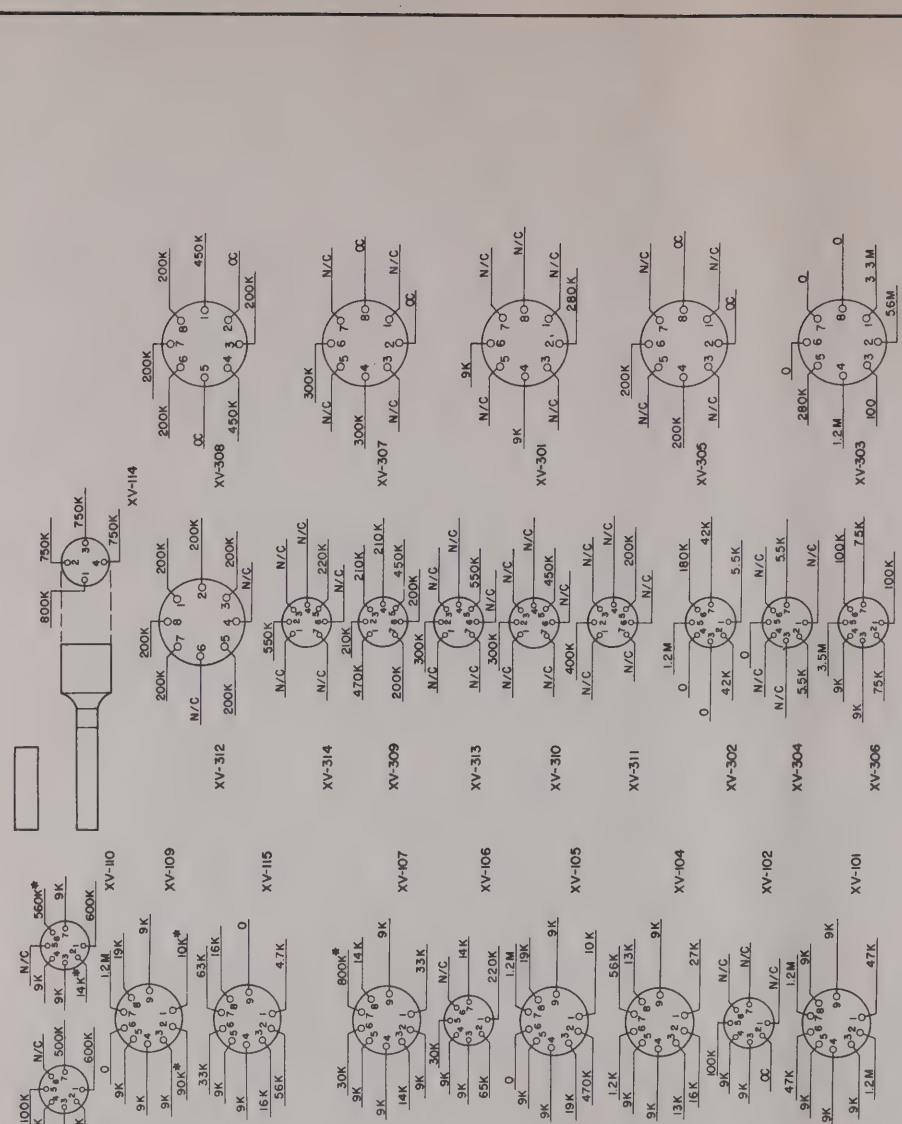


Figure 7-4. Tube Socket Resistance Measurements

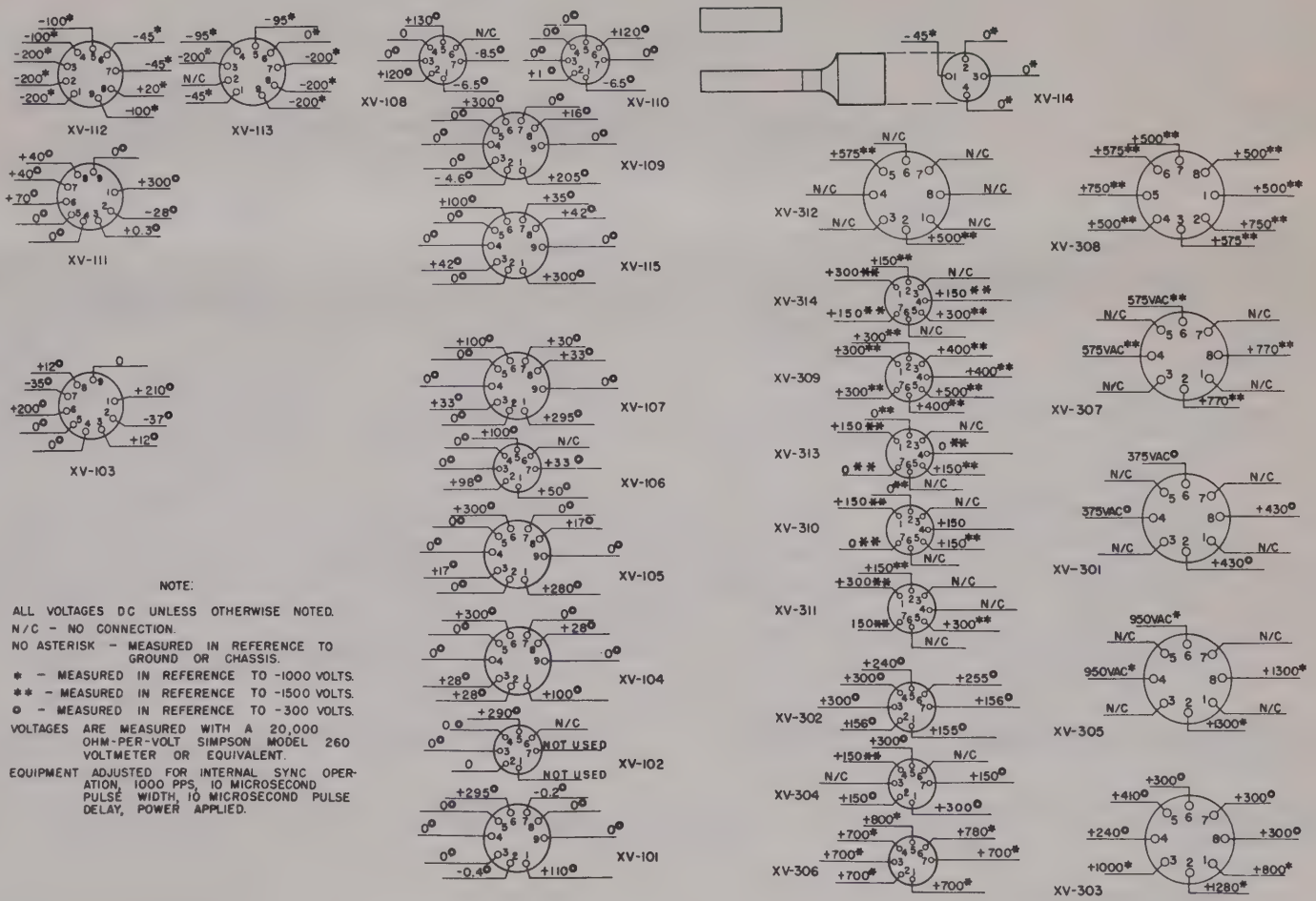


Figure 7-5. Tube Socket Voltage Measurements

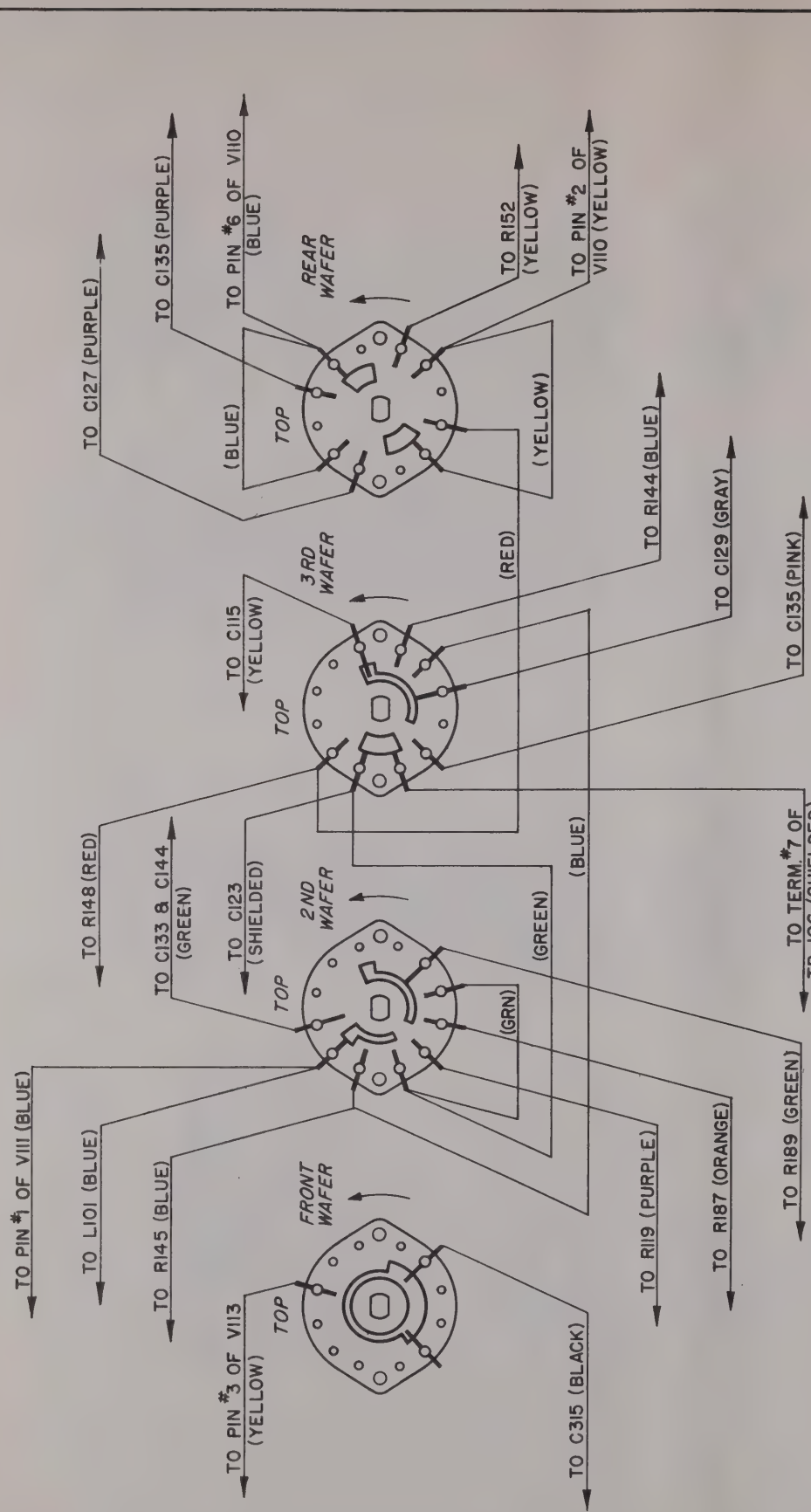


Figure 7-6. MOD SELECTOR Switch S-102, Wiring Details, Shown in EXT-FM Position, AN/URM-52, Rear View of all Sections

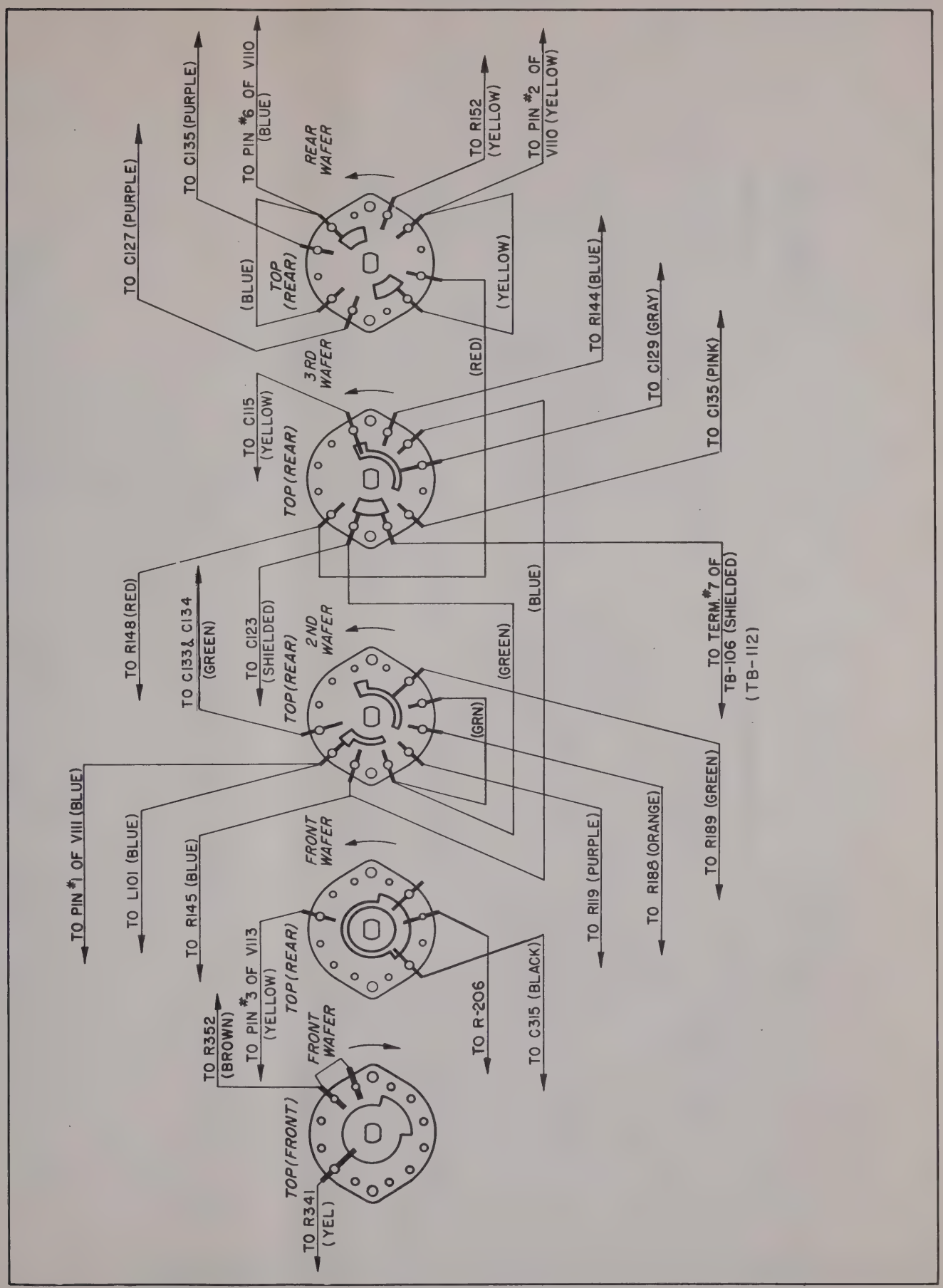


Figure 7-6A. MOD SELECTOR Switch S-102, Wiring Details Shown in EXT-FM Position, AN/URM-52A, Rear View of all Sections

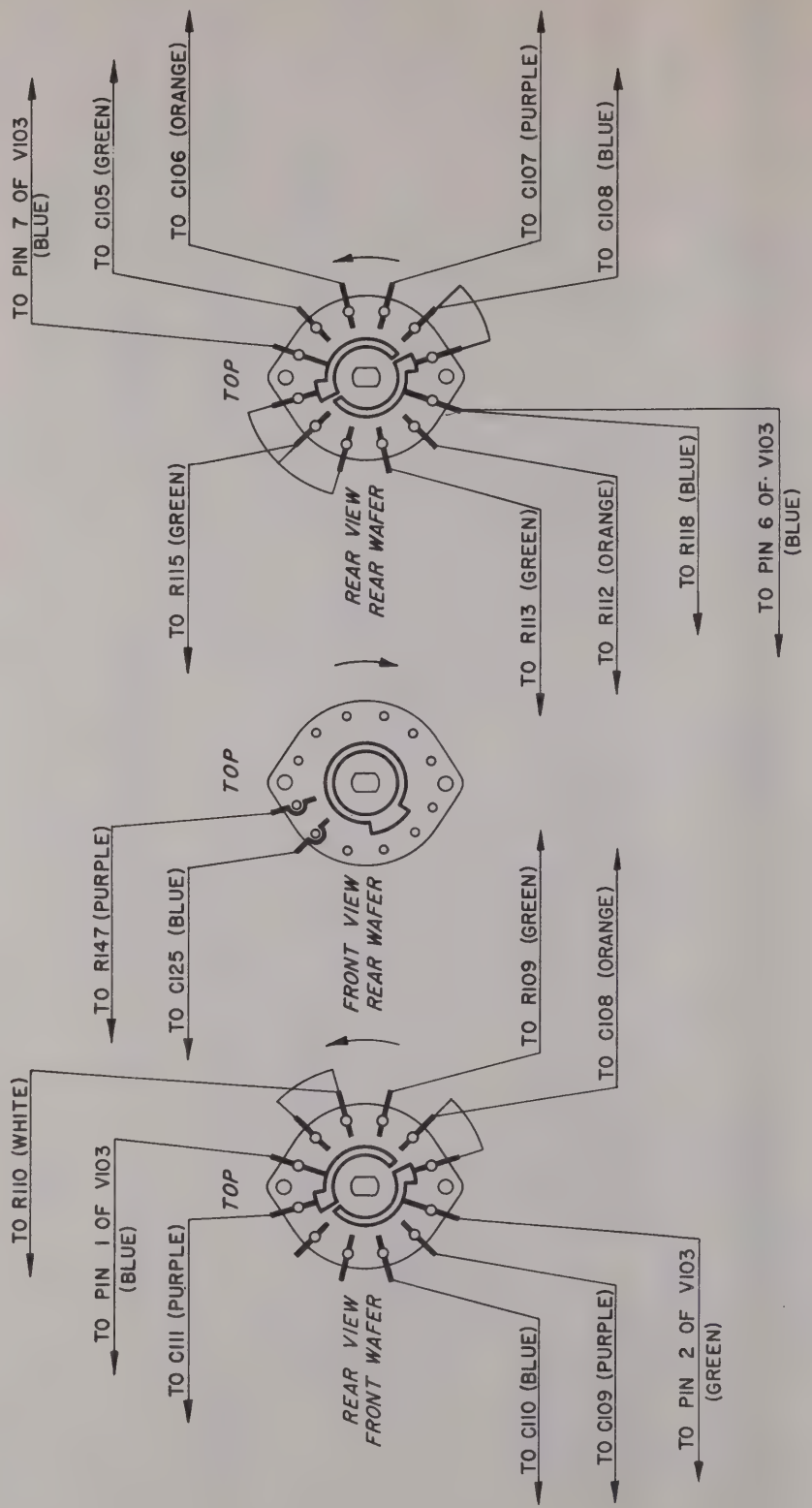


Figure 7-7. SYNC. SELECTOR Switch S-101, Wiring Details, Shown in Sine Wave Position

SECTION VIII

DIFFERENCE DATA SHEETS

SIGNAL GENERATOR AN/URM-52 A

SIGNAL GENERATOR AN/URM-52A
CONTRACT NO. N383(24)52755A
HEWLETT-PACKARD COMPANY, PALO ALTO, CALIFORNIA

The instructions contained in preceding sections of this handbook apply except for the differences given in this data sheet.

CORDS AND CABLES. The cords and cables on the AN/URM-52A covered by this Difference Data Sheet are the same as for the AN/URM-52A described in the previous sections except RF cable was changed to RF Cable CG-92E/U(6'0").

DELETED

SIGNAL GENERATOR AN/URM-52A
CONTRACT NO. N383-60516A
SERIAL NO. ML 1 THROUGH ML 269

The instructions and references contained in preceding sections of this handbook apply except for the differences noted in this data sheet.

DESCRIPTION AND LEADING PARTICULARS. Signal Generator AN/URM-52A manufactured under this contract performs the same functions and is similar to other AN/URM-52A equipment covered by this handbook except for certain mechanical and electrical design improvements. As shown in figure 8-1, the equipment supplied includes: Signal Generator TS-621C/U, Transit Case CY-2109/URM-52A, Electrical Power Cable Assembly CX-3135/U (8ft 0in.), Radio Frequency Cable Assembly CG-92E/U (6ft 0in.) and two Radio Frequency Cable Assemblies (video cords) CG-409D/U (8ft 0in.).

TUBE COMPLEMENT. The tube complement for the TS-621C/U is the same as that for the TS-621B/U except for the following:

V-102, V-106 and V-108	use 5726/6AL5W
V-103, V-104, V-105, V-107, V-109, V-111, and V-115	use 5814A
V-110	uses 5727/2D21W
V-301, V-305, and V-307	use 5R4WGA

FUSE COMPLEMENT. In the TS-621C/U, two normal blowing fuses rated 3.0 amperes are used instead of the 3.2 ampere slow-blow fuses in other AN/URM-52A equipment.

OPERATING CONTROLS. The TS-621C/U front panel operating controls and connectors are shown in figure 8-2. The function of the various controls is the same as outlined in Section I paragraph 1-9. Substitute figure 8-2 for all references to figures 1-2 and 1-2A in this paragraph. Note the following control and control position nomenclature variations:

Control	Position TS-621C/U	Position Other Equip
SYNC. SELECTOR	MUX1 MUX10	X 1 X 10
MOD SELECTOR	INTR FM INTR	INT FM INT
ON-OFF power switch	ON and OFF	ON

PREPARATION FOR USE AND RESHIPMENT. When initially removing the TS-621C/U from its transit case, check completeness of equipment against figure 8-1. Also, refer to figure 8-3 and note the difference in the construction of transit case supplied with TS-621C/U and those previously supplied. When storing the TS-621C/U and associated cords in transit case for reshipment, neatly coil the cords and secure them in place in the bottom of the case by means of the belts provided. See figure 8-3.

THEORY OF OPERATION. Figure 8-7 shows the over-all circuit configuration of the pulser and rf oscillator sections of the TS-621C/U. The schematic diagram for the over-all power supply section is shown in figure 8-8. The theory of operation of the AN/URM-52A with the TS-621C/U is the same as that discussed in Section IV for other AN/URM-52A equipments with following exceptions:

a. TS-621C/U attenuator assembly construction differs from that shown in figure 4-13 and discussed in Section IV paragraph 4-25. In the TS-621C/U attenuator assembly (See figure 8-4), the center conductor of the RG-55/U cable passes completely through the attenuator body and connects to a disc type probe resistor on the end of the probe. The disc type resistor R-203 is substituted for the platinum coated glass rod resistor R-203 used in previous equipments. The d-c resistance of the disc resistor is approximately 50 ohms.

b. In the pulse rate multivibrator circuit (figure 4-15) of the AN/URM-52A with the TS-621C/U, resistor R-110 is 100,000 ohms. Two capacitors, C-143 and C-144 are also added to this circuit to improve the low-frequency operation. Capacitor C-143 is connected across C-106 and capacitor C-144 across C-110. See figure 8-7. Also, interchange pin markings for the grid of V-103A and the plate of V-103B in figure 4-19.

c. In the pulse width multivibrator circuit (figure 4-23), the value of peaking coil L-101 is 0.250 millihenries.

ORGANIZATIONAL AND SQUADRON MAINTENANCE. Maintenance at organizational level for the AN/URM-52A with the TS-621C/U is the same as outlined in Section V except for following:

a. Substitute as follows:

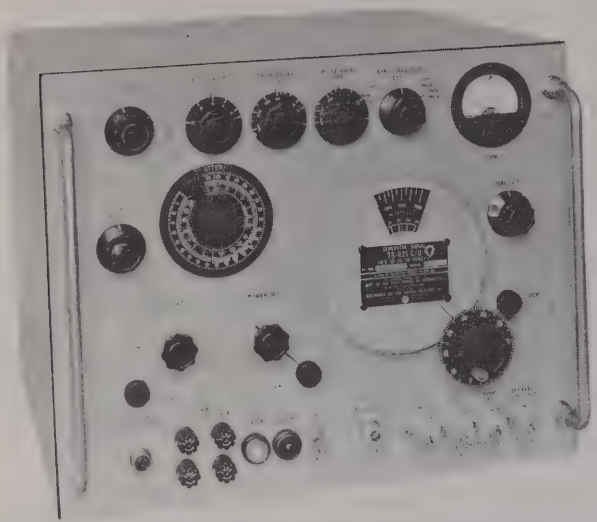
(1) Figure 8-2 for figures 1-2 and 1-2A.

(2) Figure 8-5 for figures 5-2 and 5-2A.

(3) Figure 8-7 for figures 7-1 and 7-1A.

(4) Figure 8-8 for figures 7-2 and 7-2A.

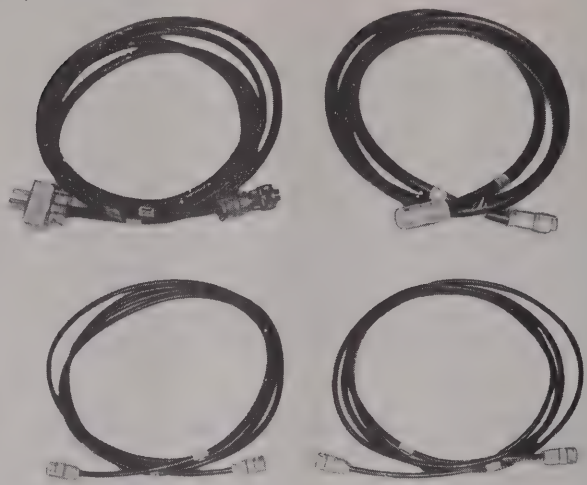
b. Refer to preceding Tube Complement paragraph



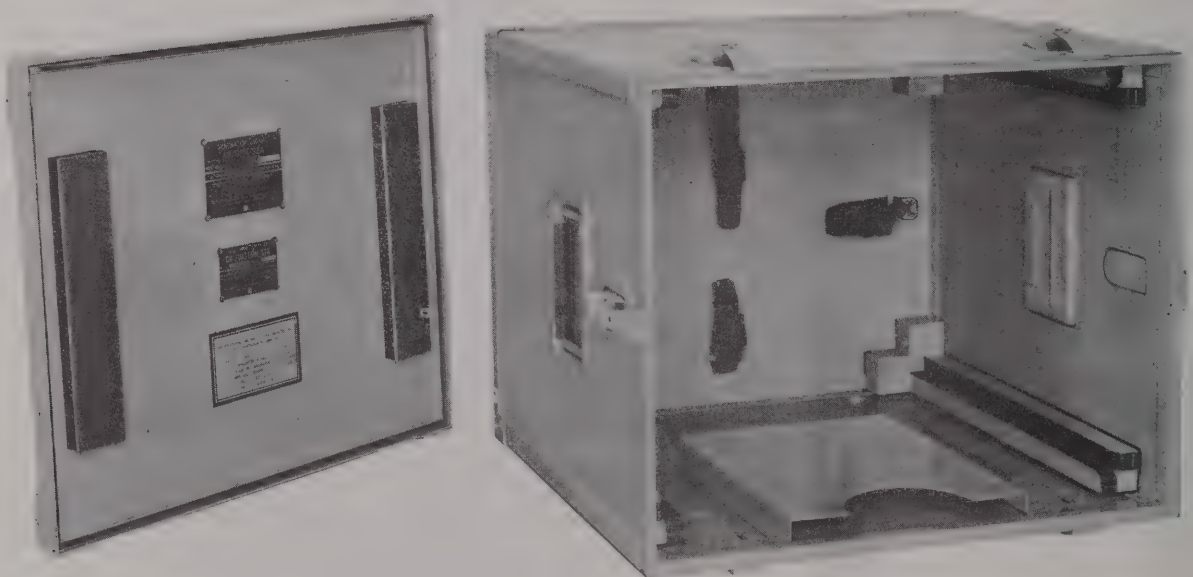
GENERATOR, SIGNAL TS-621C/U

CABLE, POWER CX-3135/U (8'-0")

CORD CG-92E/U (6'-0")



VIDEO CORDS CG-409D/U (8'-0")



CASE, SIGNAL GENERATOR CY-2109/URM-52A

Figure 8-1. Signal Generator AN/URM-52A, Equipment Supplied (Contract No. N383-60516A)

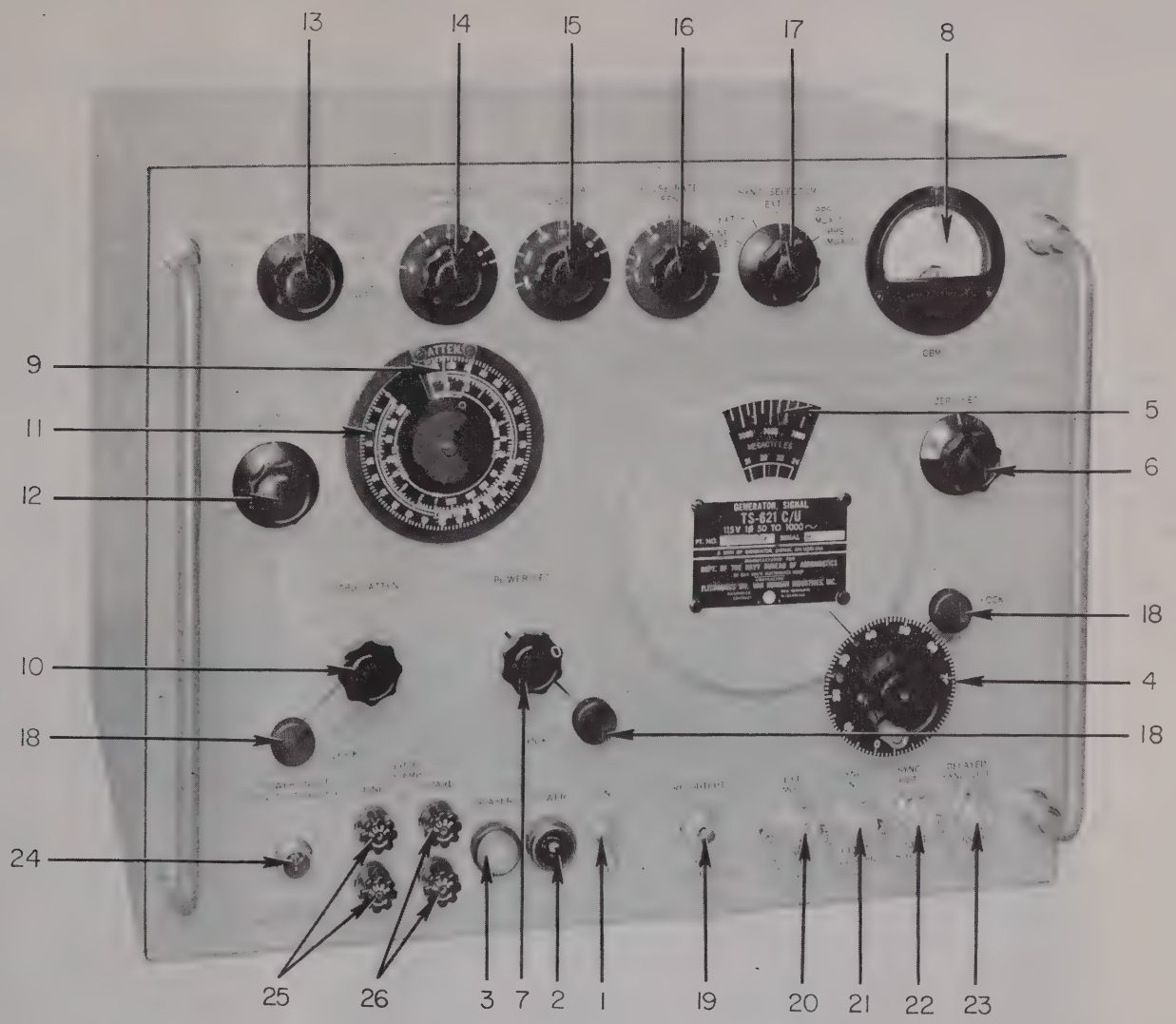


Figure 8-2. Signal Generator AN/URM-52A with TS-621C/U, Operating Controls and Connectors

1. ON OFF switch
2. POWER indicator
3. HEATER indicator
4. SIGNAL FREQUENCY control
5. MEGACYCLES dial
6. ZERO SET control
7. POWER SET control
8. DBM POWER SET meter
9. Attenuator dial index
10. OUTPUT ATTEN. control
11. OUTPUT ATTEN. dial
12. FM AMPLITUDE control
13. MOD SELECTOR switch
14. PULSE WIDTH control
15. PULSE DELAY control
16. PULSE RATE control
17. SYNC. SELECTOR switch
18. Control locks
19. RF OUTPUT connector
20. EXT MOD. connector
21. SYNC. IN connector
22. SYNC. OUT connector
23. DELAYED SYNC. OUT connector
24. POWER INPUT connector
25. Line fuseholders
26. Spare fuseholders

in these difference data sheets for the TS-621C/U prior to any tube replacement.

FIELD AND FASRON MAINTENANCE. Field and fasron maintenance is the same as noted in Section VI except for following variations:

a. Substitute as follows:

(1) Figure 8-2 for figures 1-2 and 1-2A.

(2) Figure 8-6 for figures 6-8A and 6-9.

b. Replacements are not supplied with TS-621C/U for spring (fig. 6-7 item 8) referenced in paragraphs 6-22 & 6-23. If required, requisition new springs from stock.

c. As noted in preceding paragraph, the TS-621C/U attenuator probe uses a disc type probe resistor R-203 in lieu of the platinum coated glass rod resistor referenced in Section VI paragraph 6-26. Normal d-c resistance measured between center conductor of RF OUTPUT connector and ground in attenuator probe using the disc resistor should be between 45 and 60 ohms.

d. Repeller tracking potentiometer R-174 used in the TS-621C/U is mounted to the mounting ring referenced in paragraph 6-31b and 6-32b by means of two hex nuts and lockwashers on two mounting screws supplied as an integral part of the potentiometer.

e. Substitute the following for paragraph 6-32 steps "c". and "d".

Step "c". Connect a multimeter across R-174 terminals 1 and 3 (as viewed from the front panel) and set meter to read on low-resistance scale.

Step "d". Rotate FREQUENCY control to obtain an indication of 4250 megacycles on the frequency dial. Rock the FREQUENCY control in the vicinity of 4250 megacycles while observing the multimeter for a null indication. Null should be obtained within ± 20 megacycles of this point. If null is not found within these limits, adjust FREQUENCY control for 4250 megacycle indication and lock control in this position. Loosen the two front setscrews on the R-174 shaft coupler, turn R-174 shaft by hand until a null is obtained and tighten the coupler setscrews.

DIAGRAMS. The circuit configurations of the AN/URM-52A with the TS-621C/U are shown in figures 8-7, 8-8 and 8-9. For part numbers of various circuit elements which differ from those used in other AN/URM-52A equipment, refer to the Illustrated Parts Breakdown.

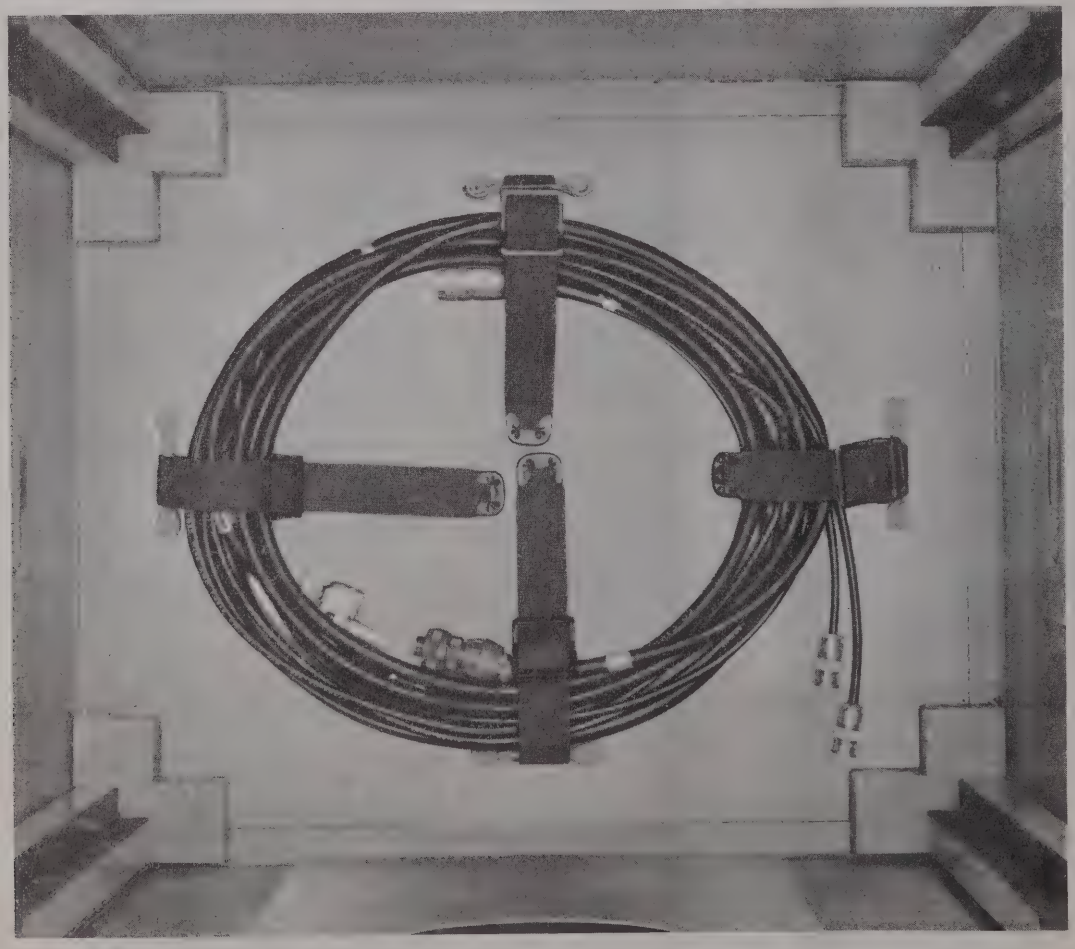


Figure 8-3. Location of Accessories in Transit Case (Contract No. N383-60516A)

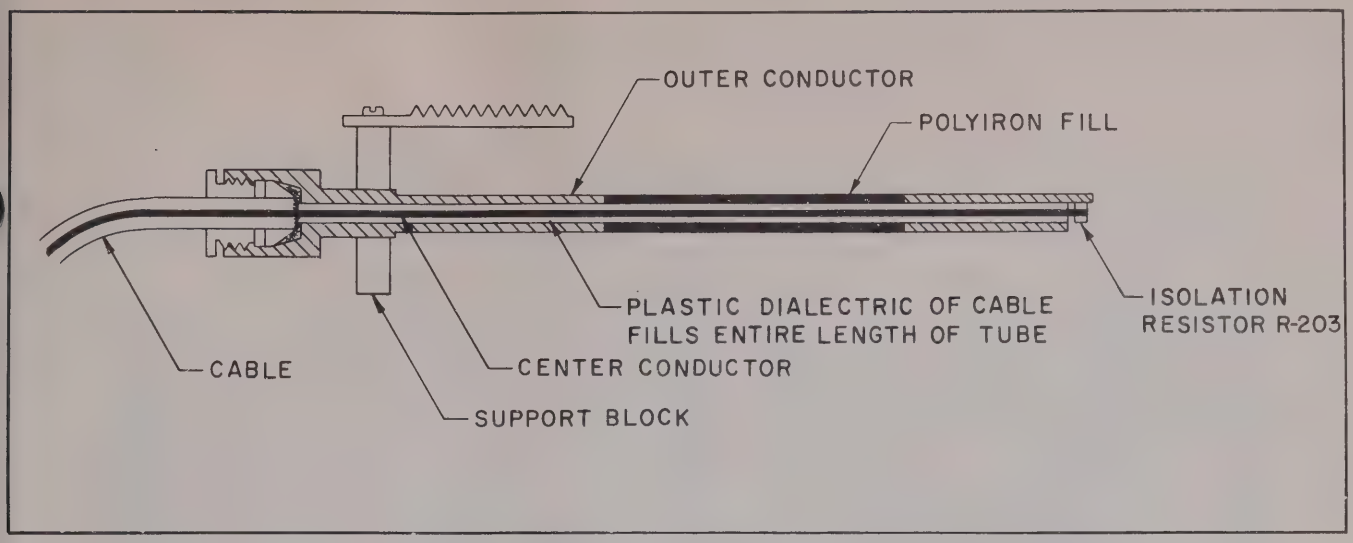


Figure 8-4. Cutaway View of Attenuator Probe, TS-621C/U

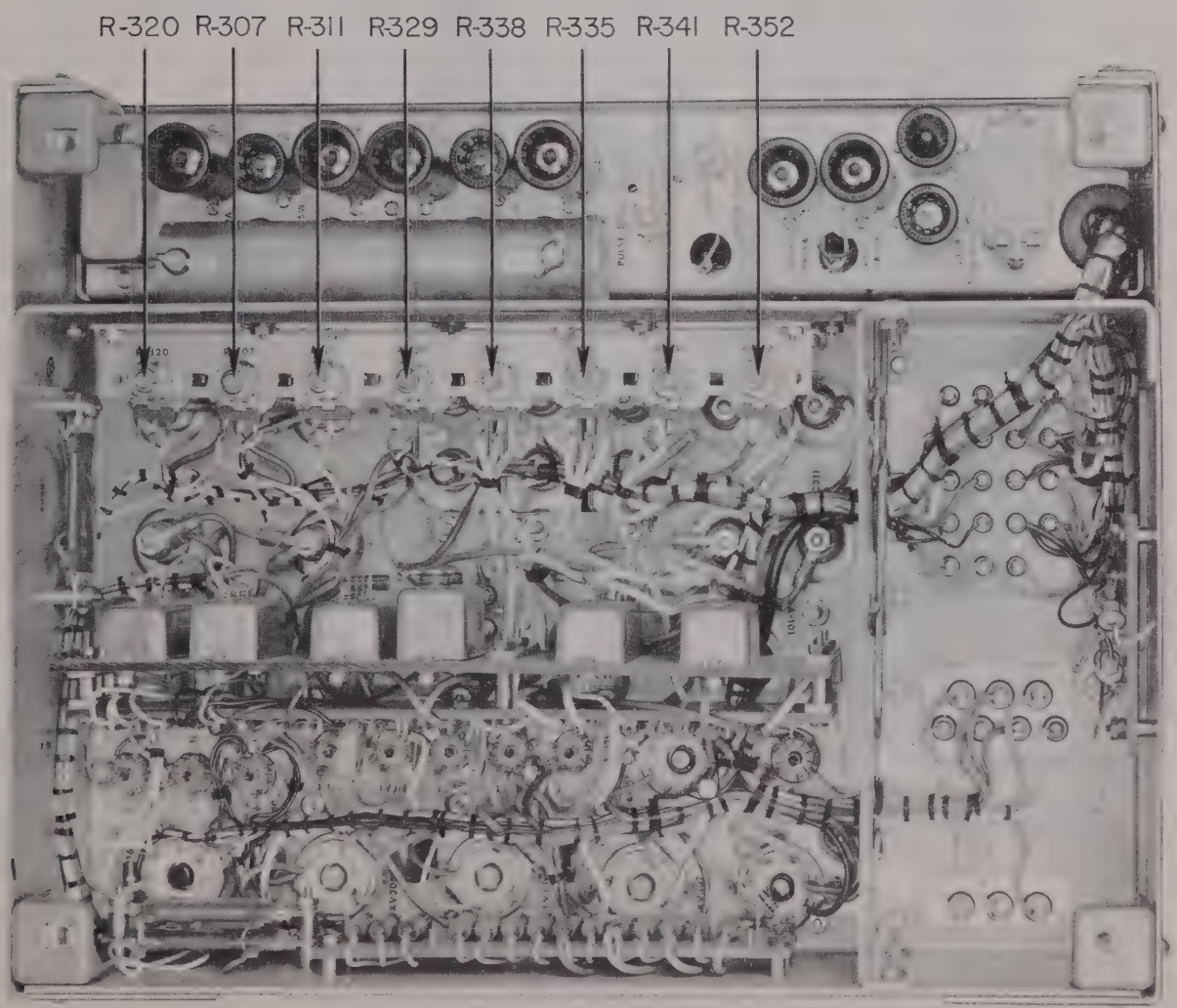


Figure 8-5. Location of Internal Controls, TS-621C/U Power Supply

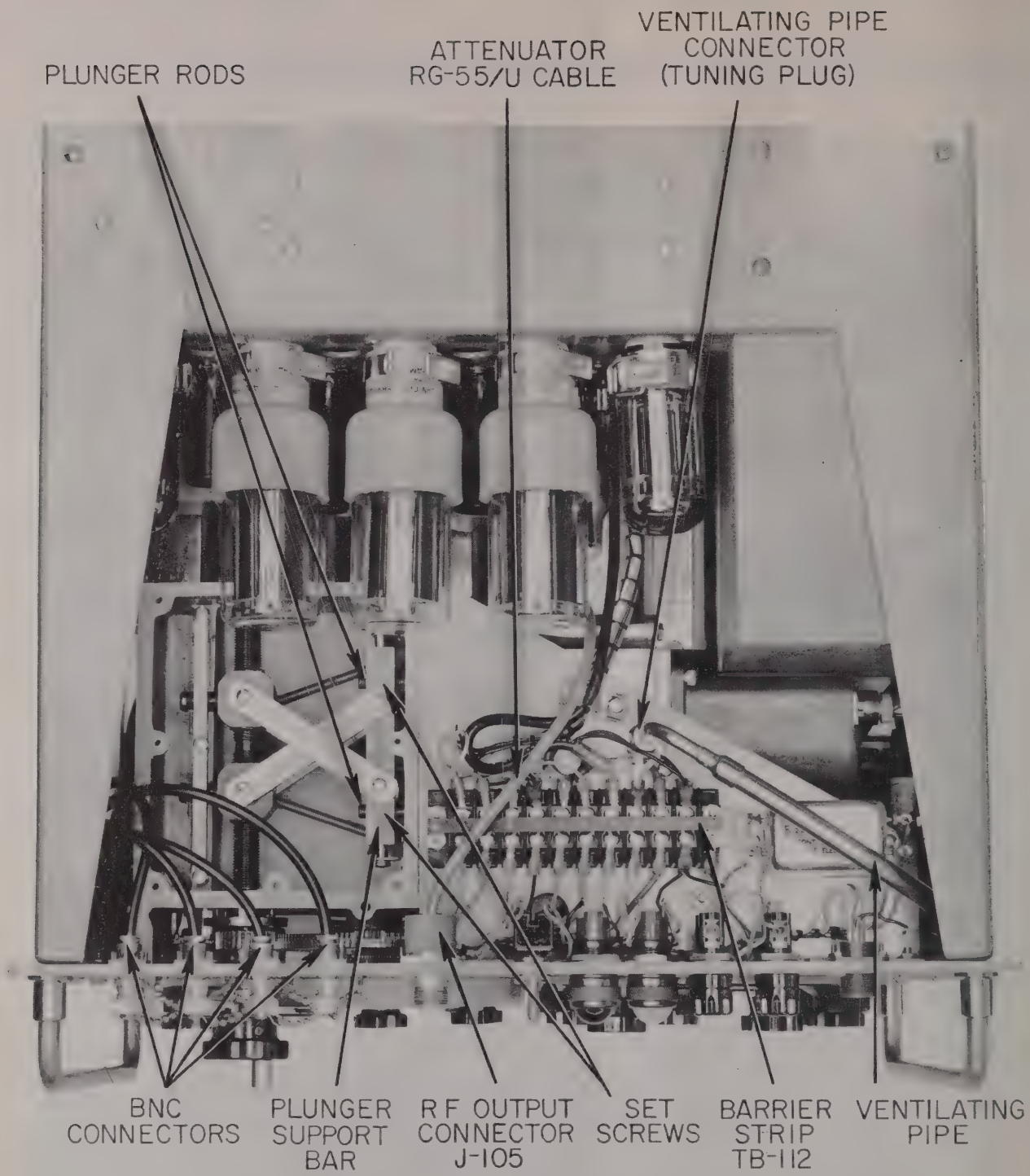
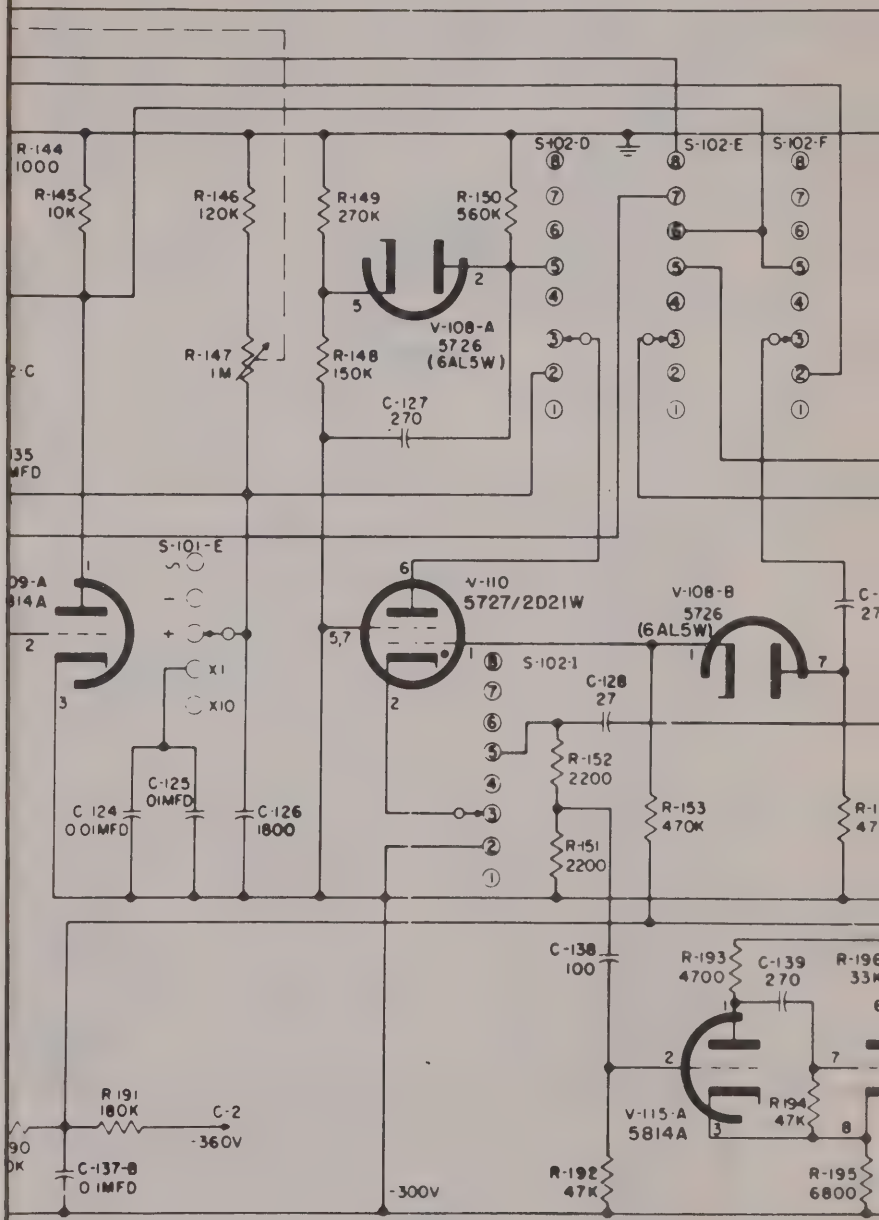
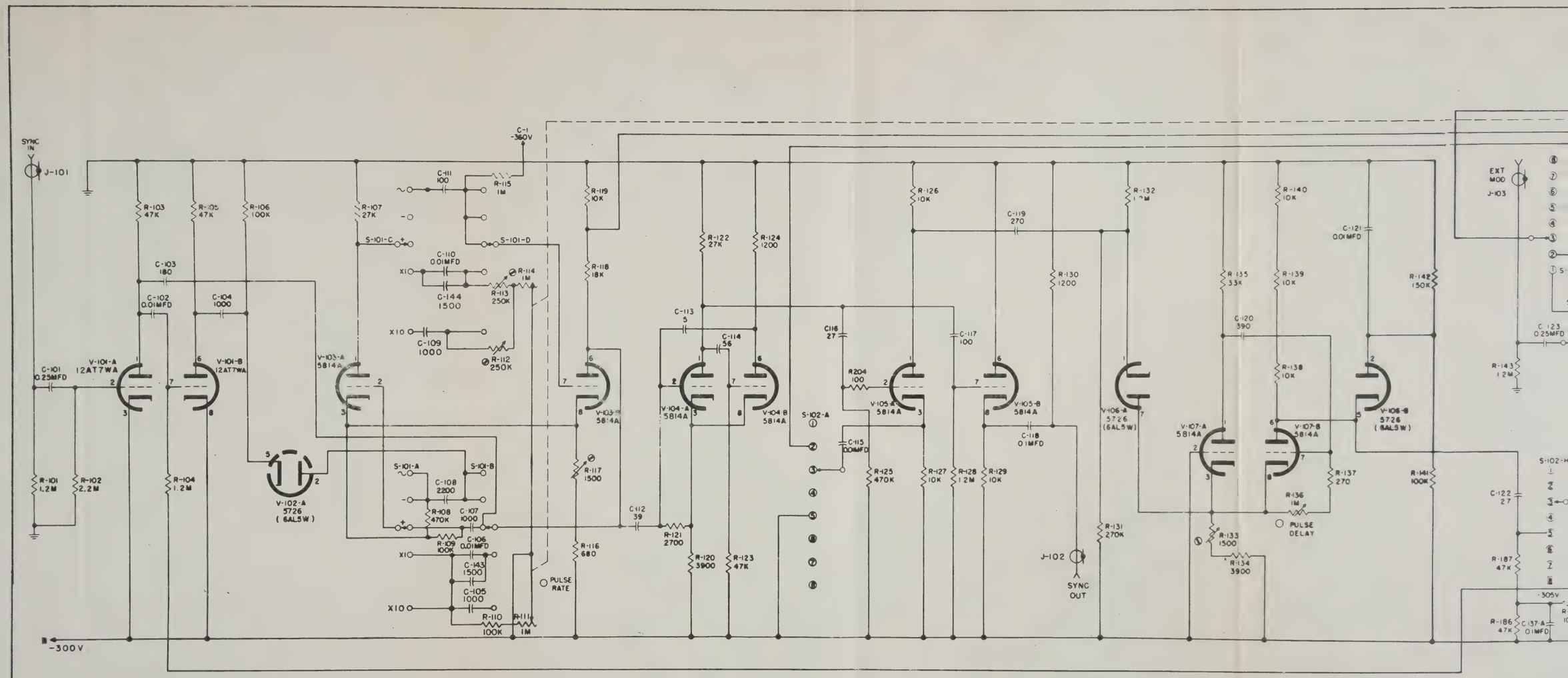


Figure 8-6. Frequency Control Assembly, Signal Generator TS-621C/U, Bottom View


R-144
1000
R-145
10K
R-146
120K
R-147
1M
R-148
150K
R-149
270K
R-150
560K
V-108-A
5726
(6AL5W)
C-127
270
S-102-D
S-102-E
S-102-F
S-101-E
X1
X10
V-110
5727/2D21W
V-108-B
5726
(6AL5W)
S-102-1
C-128
27
R-152
2200
R-151
2200
R-153
470K
C-124
0 01MFD
C-125
01MFD
C-126
1800
C-138
100
R-193
4700
C-139
270
V-115-A
5814A
R-194
47K
R-191
180K
C-2
-360V
C-137-B
0 1MFD
-300V
R-192
47K
R-195
6800


SYNC IN
J-101
C-1 -360V
R-103 47K
R-105 47K
R-106 100K
R-107 27K
C-111 100
R-115 1M
S-101-C
S-101-D
C-110 0.01MFD
C-144 1500
R-114 1M
R-113 250K
C-109 1000
R-112 250K
C-103 180
C-102 0.01MFD
C-104 1000
C-101 0.25MFD
V-101-A 12AT7WA
V-101-B 12AT7WA
V-103-A 5814A
V-102-A 5726 (6AL5W)
R-101 1.2M
R-102 2.2M
R-104 1.2M
S-101-A
S-101-B
C-108 2200
R-108 470K
C-107 1000
R-109 100K
C-106 0.01MFD
C-143 1500
C-105 1000
R-110 100K
R-111 1M
PULSE RATE
R-117 1500
R-116 680
C-112 39
R-119 10K
R-118 18K
V-103-B 5814A
R-122 27K
R-124 1200
C-113 5
C-114 56
V-104-A 5814A
V-104-B 5814A
R-121 2700
R-120 3900
R-123 47K
S-102-A
C116 27
R204 100
V-105-A 5814A
C-115 .001MFD
R-125 470K
R-126 10K
R-127 10K
R-128 1.2M
R-129 10K
C-117 100
V-105-B 5814A
C-118 .01MFD
C-119 270
R-130 1200
J-102
SYNC OUT
R-131 270K
R-132 1.2M
V-106-A 5726 (6AL5W)
R-135 33K
C-120 390
R-133 1500
R-134 3900
V-107-A 5814A
R-140 10K
R-139 10K
R-138 10K
R-136 1M
PULSE DELAY
V-107-B 5814A
C-121 0.01MFD
R-142 150K
V-106-B 5726 (6AL5W)
R-137 270
R-141 100K
EXT MOD J-103
C-123 0.25MFD
R-143 1.2M
S-102-K
C-122 27
R-187 47K
-305V
R-186 47K
C-137-A .01MFD
-300V

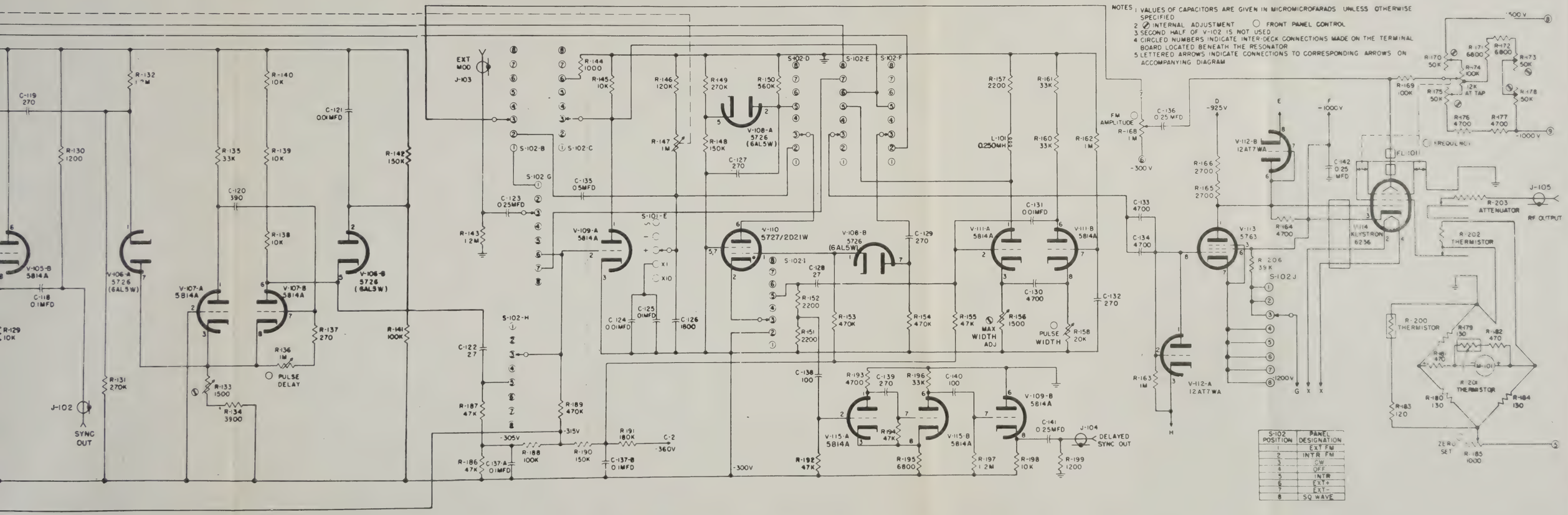
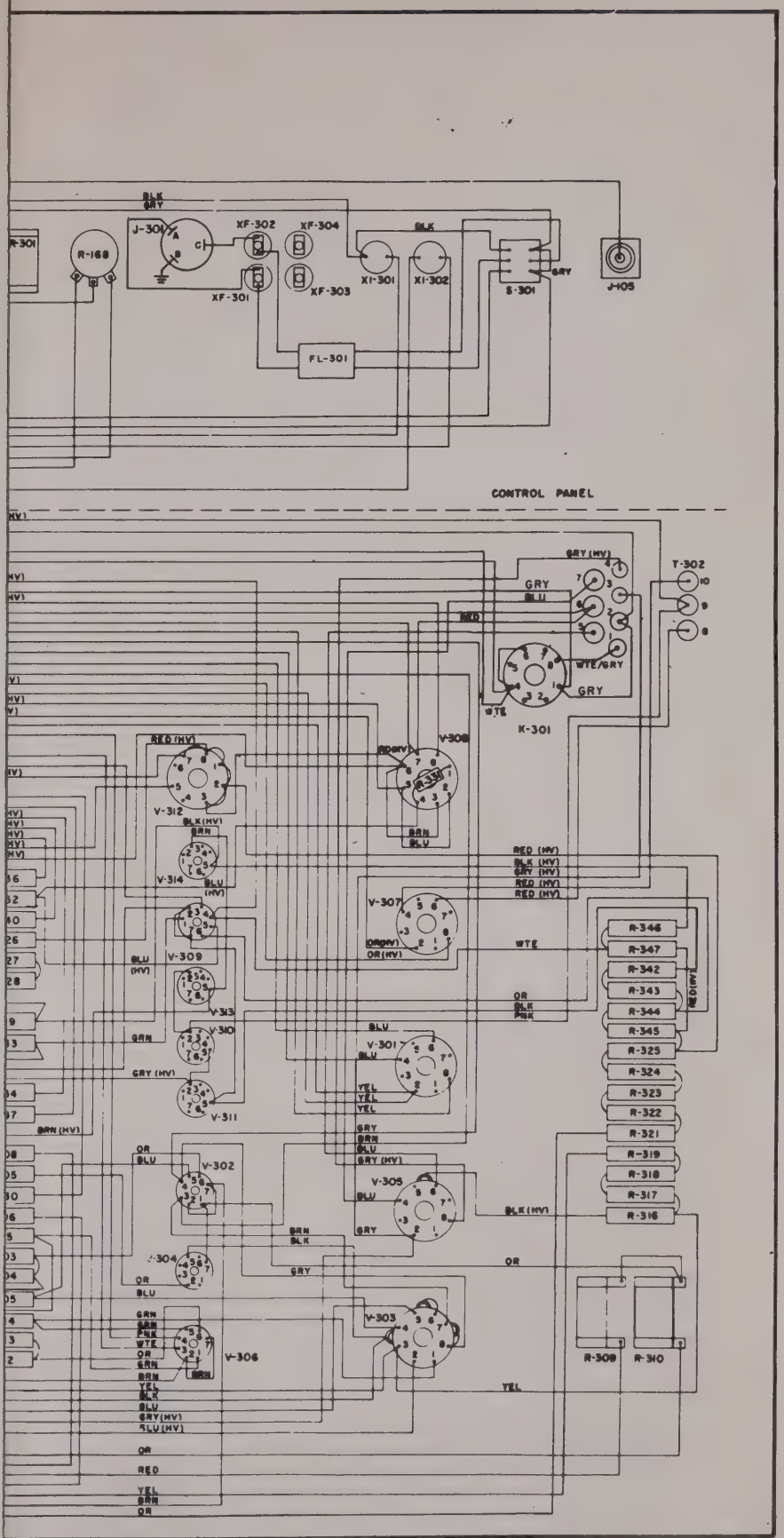
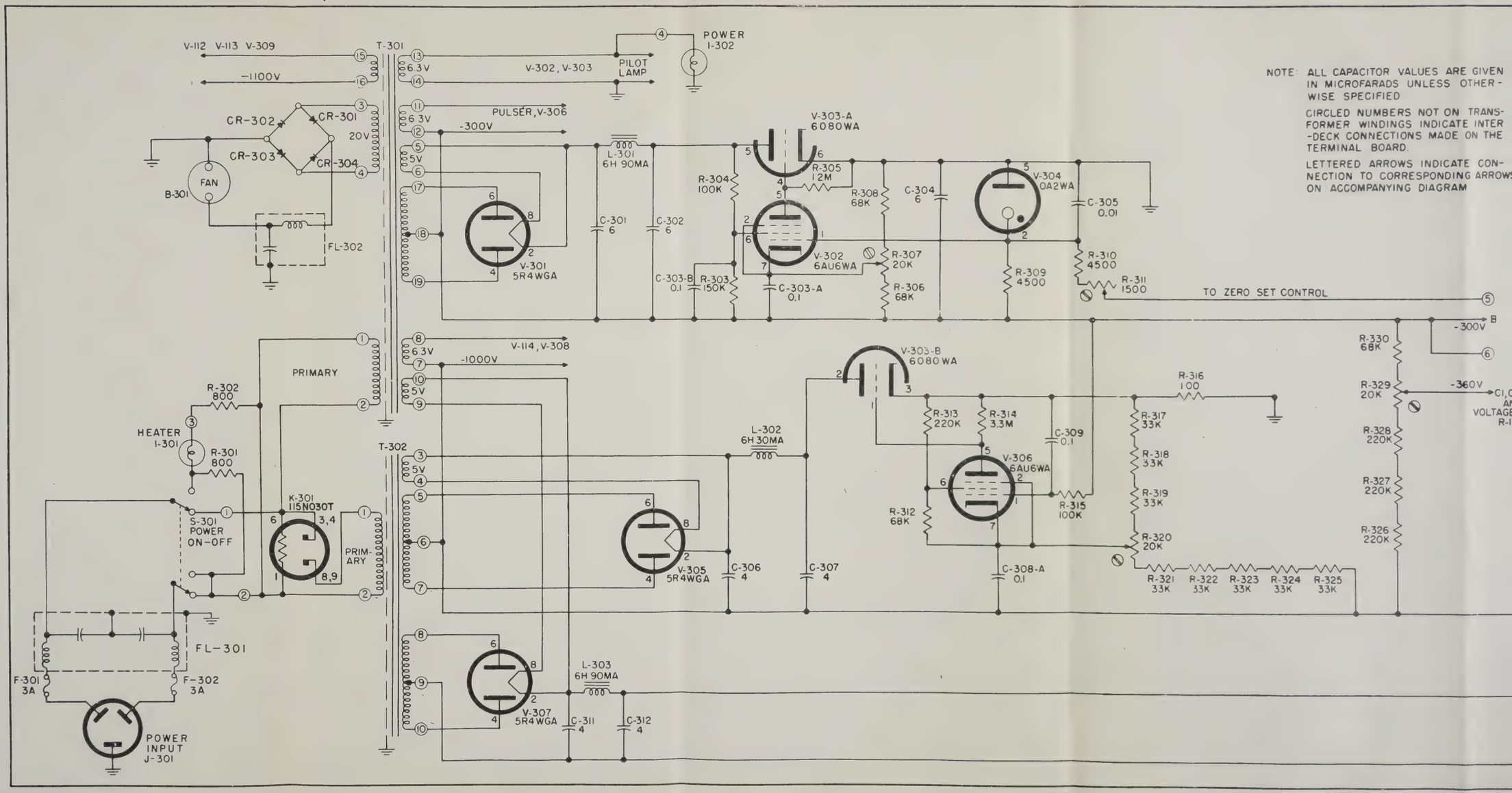


Figure 8-7. Schematic Diagram of Pulser and RF Oscillator Sections of TS-621C/U



actical Wiring Diagram, Signal Generator TS-621C/U



NOTE: ALL CAPACITOR VALUES ARE GIVEN IN MICROFARADS UNLESS OTHERWISE SPECIFIED

CIRCLED NUMBERS NOT ON TRANSFORMER WINDINGS INDICATE INTER-DECK CONNECTIONS MADE ON THE TERMINAL BOARD.

LETTERED ARROWS INDICATE CONNECTION TO CORRESPONDING ARROWS ON ACCOMPANYING DIAGRAM

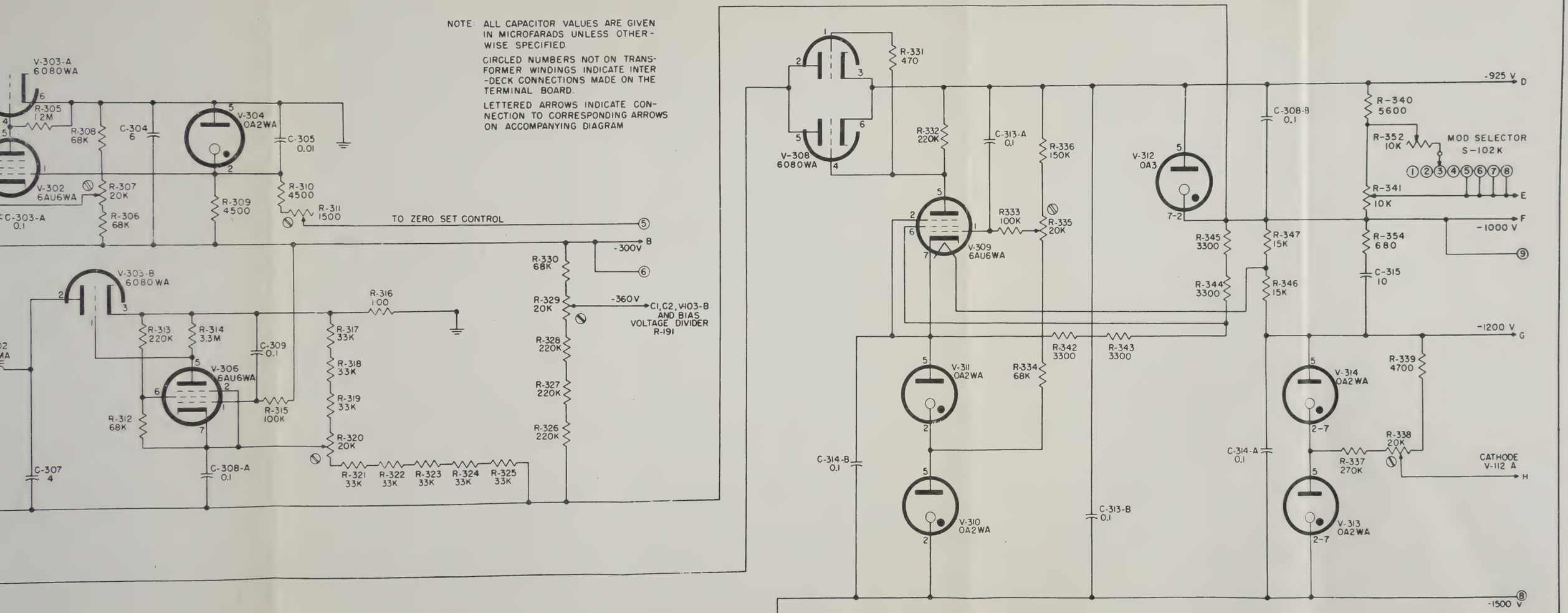


Figure 8-8. Schematic Diagram of Power Supply Section of TS-621C/U

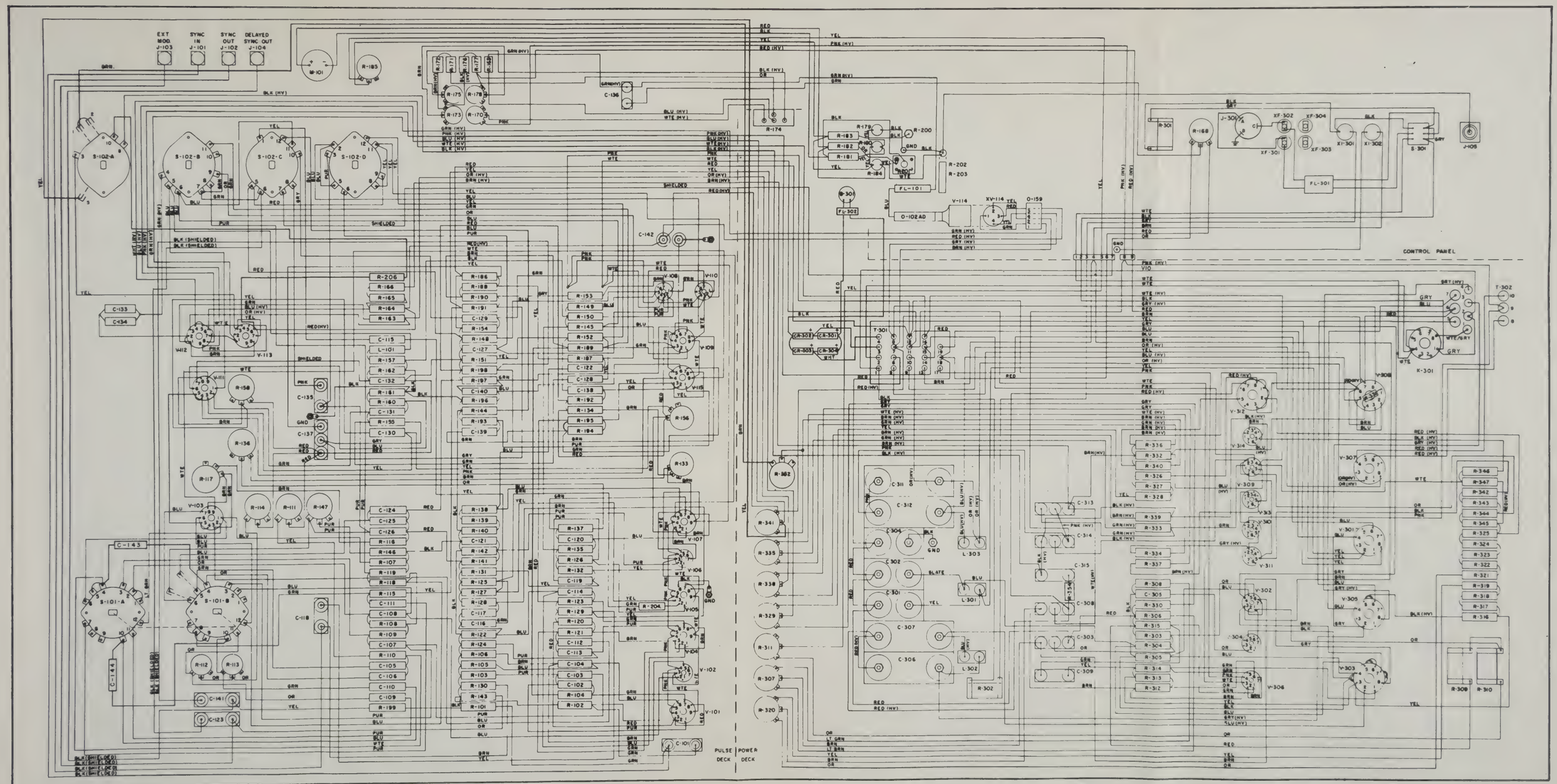


Figure 8-9. Practical Wiring Diagram, Signal Generator TS-621C/U

SECTION VIII

DIFFERENCE DATA SHEETS

SIGNAL GENERATOR AN/URM-52B
CONTRACT N383(24-MIS)83965A

The instructions and references contained in preceding sections of this manual apply except for the differences noted in this section.

8-2. DESCRIPTION AND LEADING PARTICULARS. Signal Generator AN/URM-52B performs the same functions as the AN/URM-52 and AN/URM-52A. The major changes and improvements are contained in the following paragraphs.

8-3. EQUIPMENT SUPPLIED. (See figure 8-10). The Signal Generator AN/URM-52B is supplied with the following equipment:

a. Signal Generator	SG-557/U
b. Transit Case	CY-4305/URM-52B
c. RF Cable	CG-92E/U
d. Video Cable	CG-409D/U
e. Power Cable	CX-3135/U
f. Allen Wrenches	H-301, H-302, H-303, H-304, H-306
g. Hexagonal Wrench	H-305

8-4. TUBE AND DIODE COMPLEMENT. Table 8-1 lists the number, type and function of the electron tubes and diodes used in the Signal Generator SG-557/U.

8-5. INPUT POWER REQUIREMENTS. Input Power for the SG-557/U shall be within the limits specified below.

a. Voltage	115 Volts single phase
b. Frequency	60 to 400 cycles
c. Current	2.1 Amps.

8-6. POWER TRANSFORMER AND RECTIFIER CIRCUITS. The power supply circuits have been modified to use silicon diode type rectifiers in place of the 5R4 electron tube type rectifiers. This eliminated the need for one of the filament windings on T-301 and the two filament windings on T-302 which were used to supply heater voltages for the electron tubes. Silicon diodes replace electron tubes as follows:

a. CR-305 and CR-306 replace V301
b. CR-307 and CR-308 replace V305
c. CR-309 and CR-310 replace V307

The high voltage windings of transformers T-301 and T-302 have been reduced in voltage to compensate for the voltage drop which normally occurs in a vacuum tube. This voltage drop is very small, approximately 0.7 volts, in a silicon diode type rectifier.

8-7. VENTILATION. Forced air cooling is not required for the AN/URM-52B. The blower has been eliminated from the equipment and the heat dissipation is accomplished by use of heat dissipating tube shields on the electron tubes, however the equipment must be located so that the louvers are clear and free to allow adequate air intake by convection.

Figure 8-10. Signal Generator AN/URM-52B Equipment Supplied

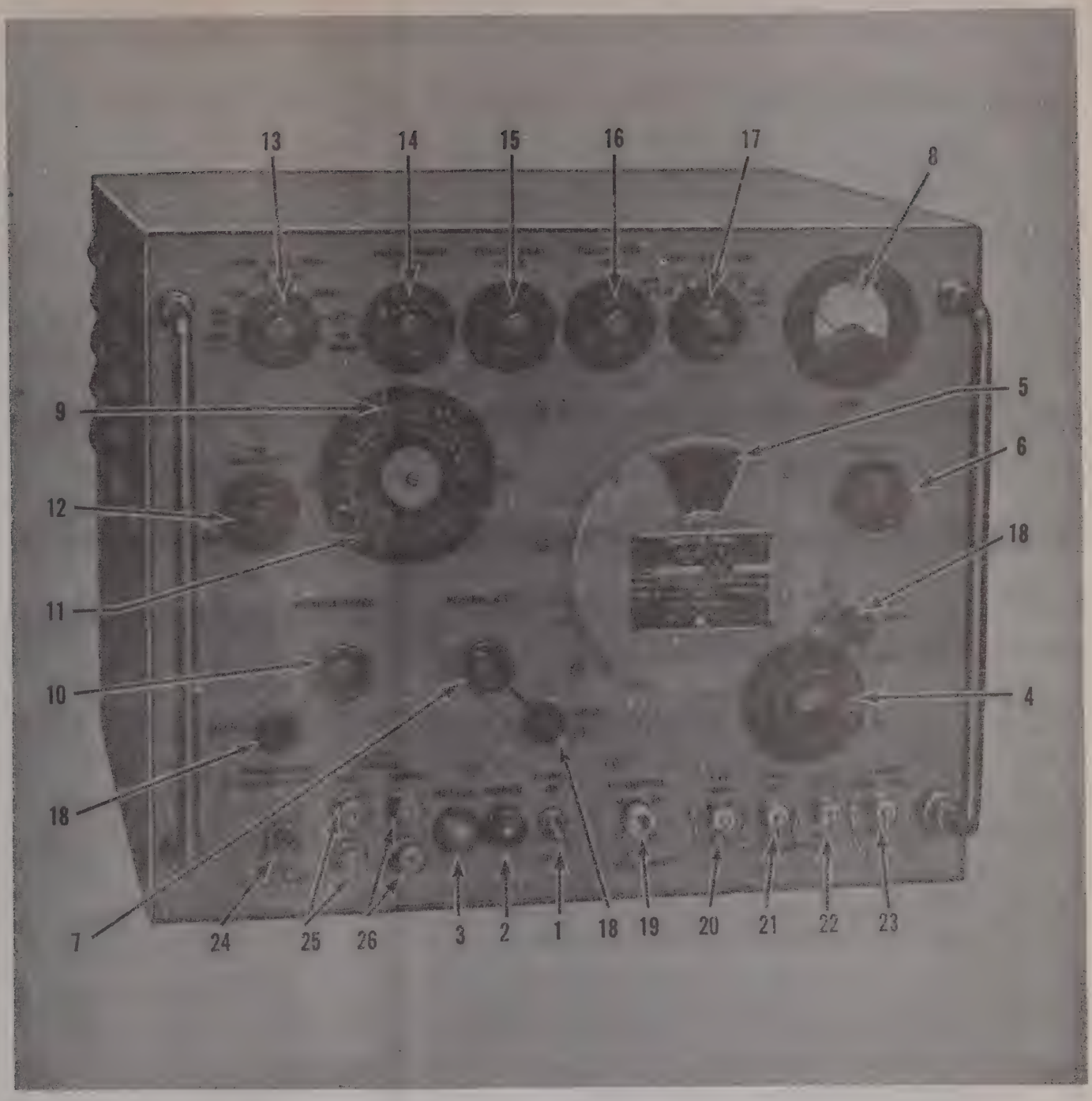


Figure 8-11. Signal Generator SG-557. Operating Controls and Connectors

1. ON OFF switch
2. POWER indicator
3. HEATER indicator
4. SIGNAL FREQUENCY control
5. MEGACYCLES dial
6. ZERO SET control
7. POWER SET control
8. DBM POWER SET meter
9. Attenuator dial index
10. OUTPUT ATTEN. control
11. OUTPUT ATTEN. dial
12. FM AMPLITUDE control
13. MOD SELECTOR switch
14. PULSE WIDTH control
15. PULSE DELAY control
16. PULSE RATE control
17. SYNC. SELECTOR switch
18. Control locks
19. RF OUTPUT connector
20. EXT MOD. connector
21. SYNC. IN connector
22. SYNC. OUT connector
23. DELAYED SYNC. OUT connector
24. POWER INPUT connector
25. Line fuseholders
26. Spare fuseholders

TABLE 8-1. TUBE AND DIODE COMPLEMENT SIGNAL GENERATOR SG-557/U

Tube or Diode	Type Number	Function
V101	12AT7WB	SYNC. IN amplifier and inverter
V102	5726/6AL5W	Coupling diode (1/2 tube not used)
V103*	5814A	Pulse rate multivibrator
V104	5814A	SYNC. OUT pulse shaping multivibrator
V105	5814A	Pulse amplifier and SYNC. OUT multivibrator
V106	5726/6AL5W	Base limiter and clamp for delay multivibrator
V107	5814A	PULSE DELAY multivibrator
V108	5726/6AL5W	Clamp and negative pulse clipper
V109	5814A	Pulse ampl. inverter and DELAYED SYNC. OUT
V110	5727/2D21W	Thyratron pulse shaper
V111*	5814A	PULSE WIDTH multivibrator
V112*	12AT7WB	Clipper and klystron grid clamp
V113*	5763	Modulator
V114*	6236	Radio Frequency oscillator
V115	5814A	DELAYED SYNC. OUT pulse shaping multivibrator
V302*	6AU6WB	Regulator amplifier
V303*	6080WB	Series regulator
V304*	0A2WA	Voltage regulator
V306*	6AU6WB	Regulator amplifier
V308*	6080WB	Series regulator
V309*	6AU6WB	Regulator amplifier
V310*	0A2WA	Voltage regulator
V311*	0A2WA	Voltage regulator
V312*	0A3	Voltage regulator
V313*	0A2WA	Voltage regulator
V314*	0A2WA	Voltage regulator
CR305	1N1734	Rectifier
CR306	1N1734	Rectifier
CR307	1N1731	Rectifier
CR308	1N1731	Rectifier
CR309	1N1733	Rectifier
CR310	1N1733	Rectifier

See paragraph 8-6

* See Section VI for replacement instruction

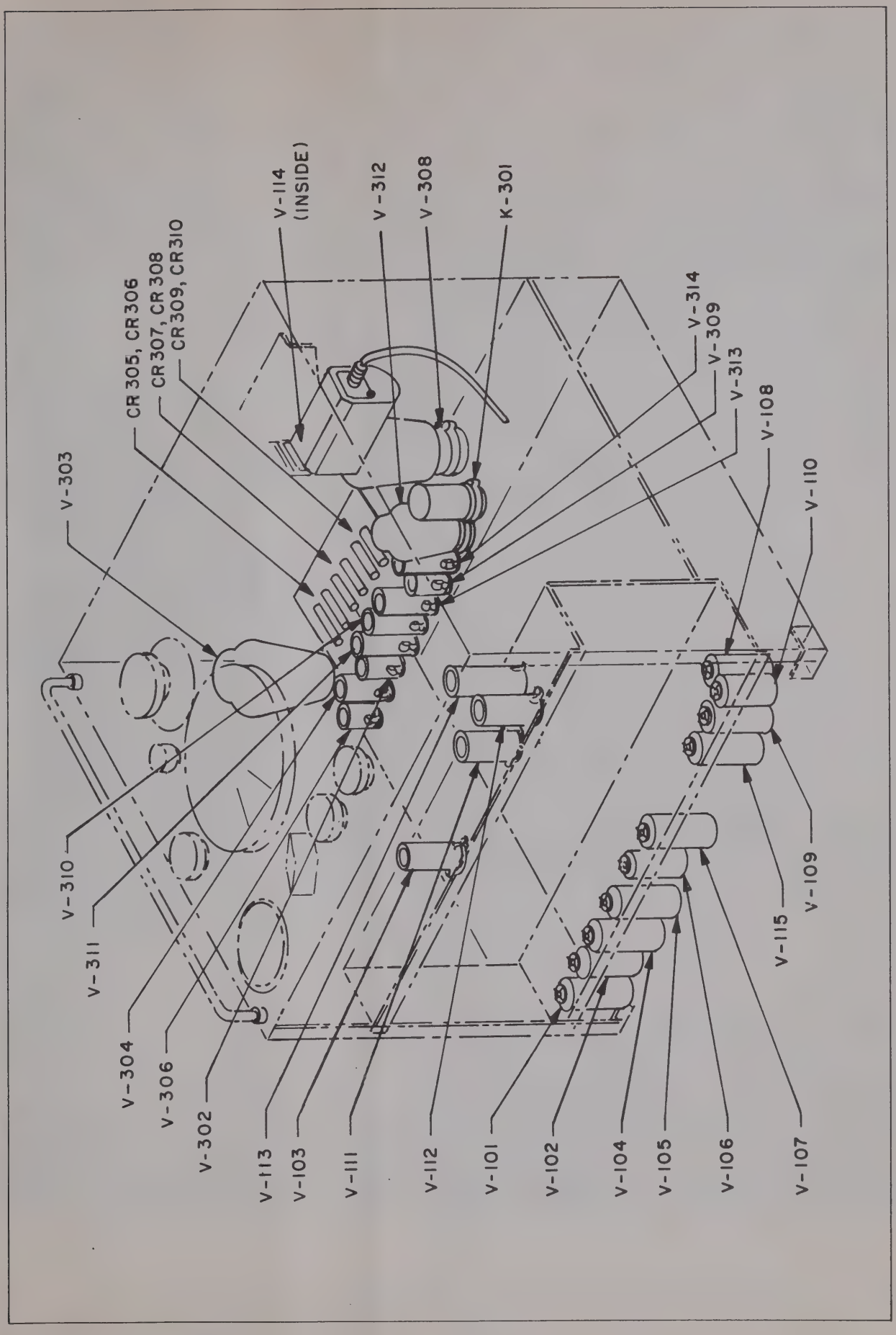


Figure 8-12. Location of Tubes and Diodes, SG-557/U

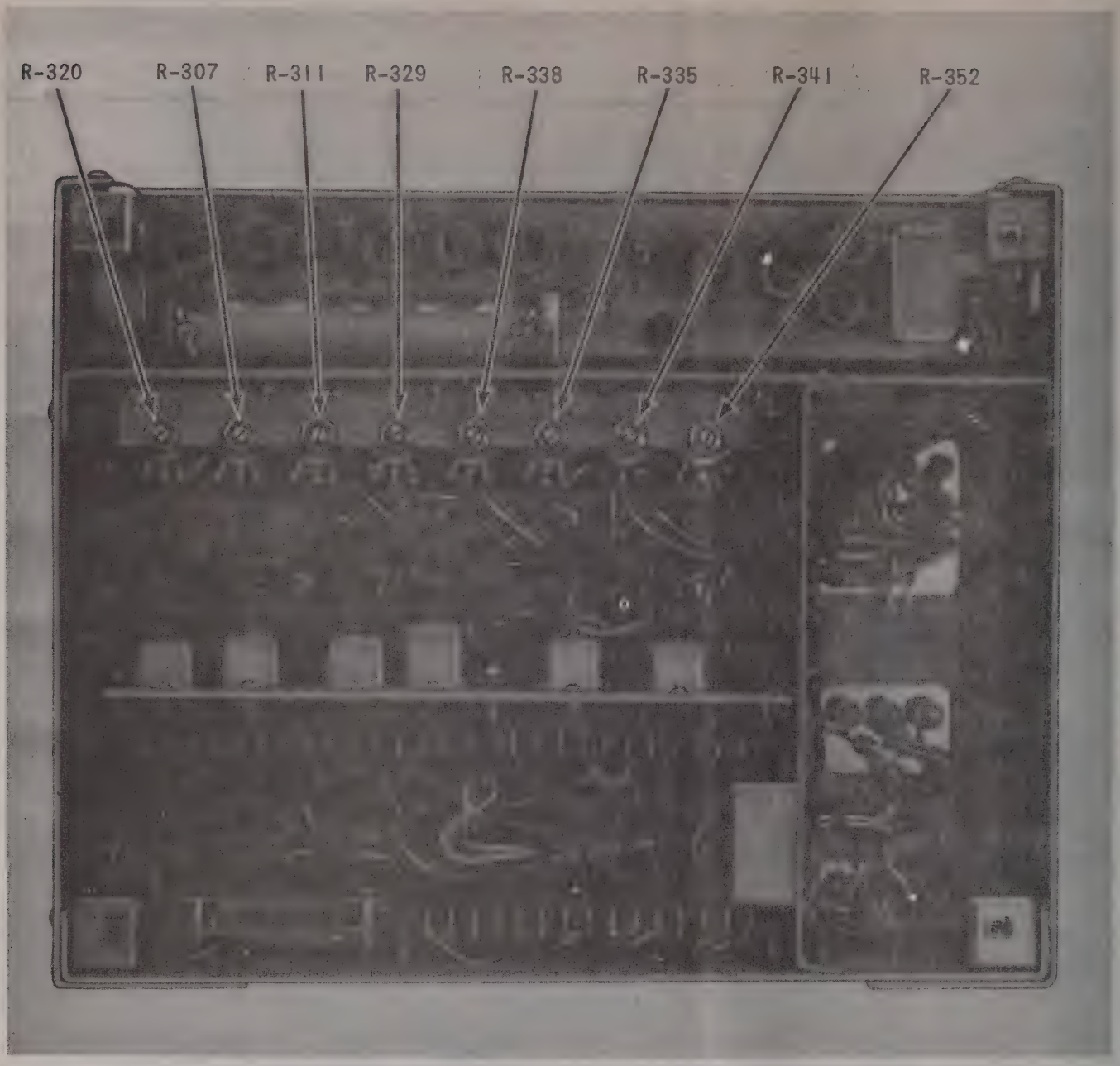


Figure 8-13. Location of Internal Controls, SG-557/U Power Supply

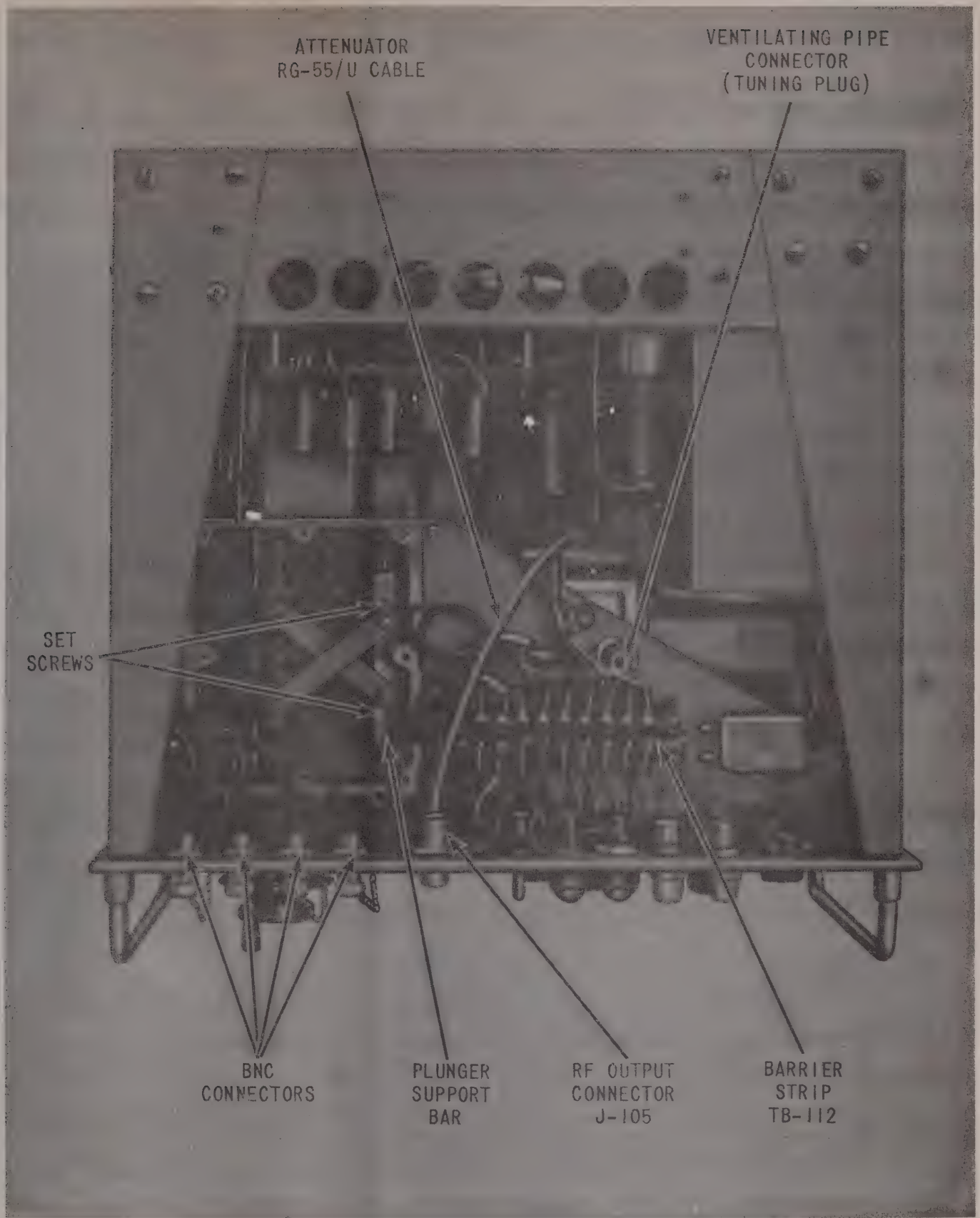
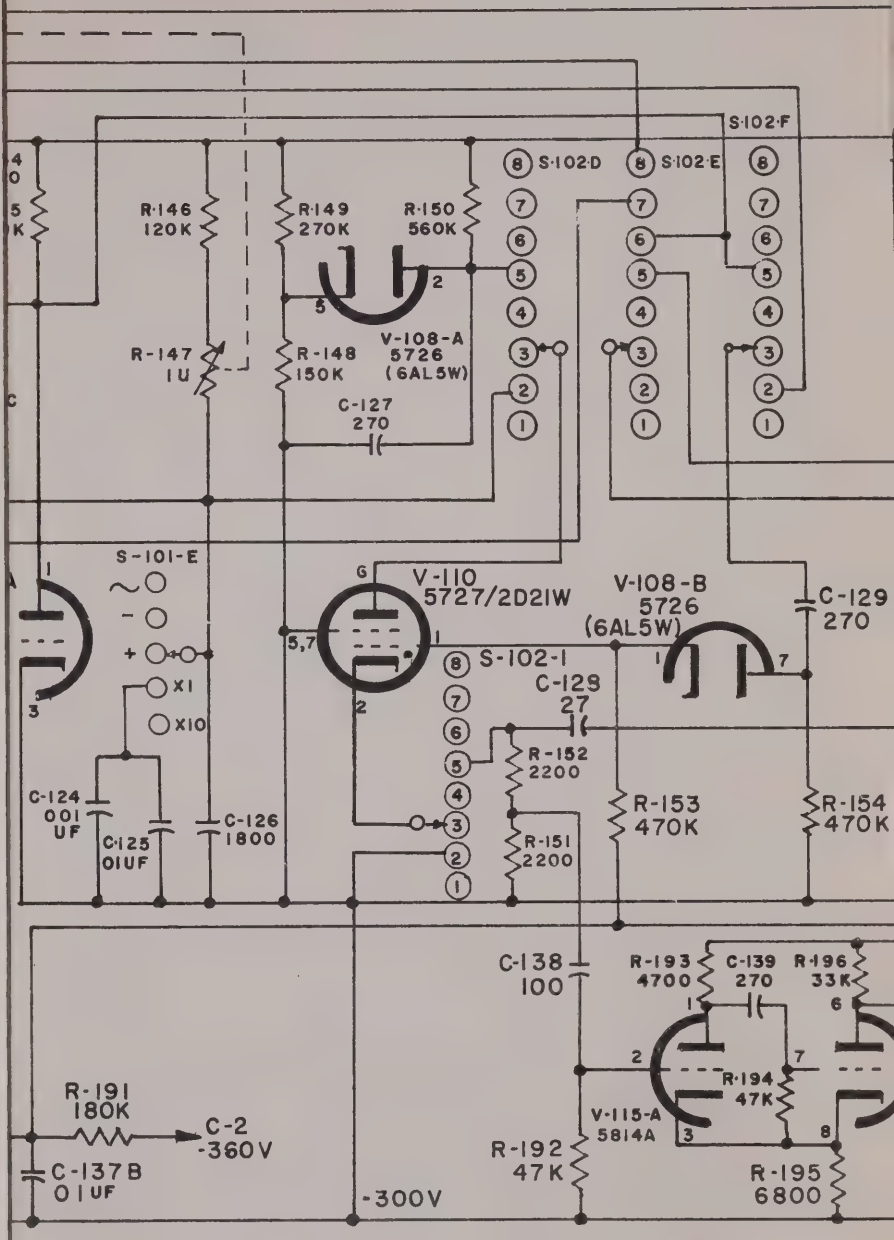
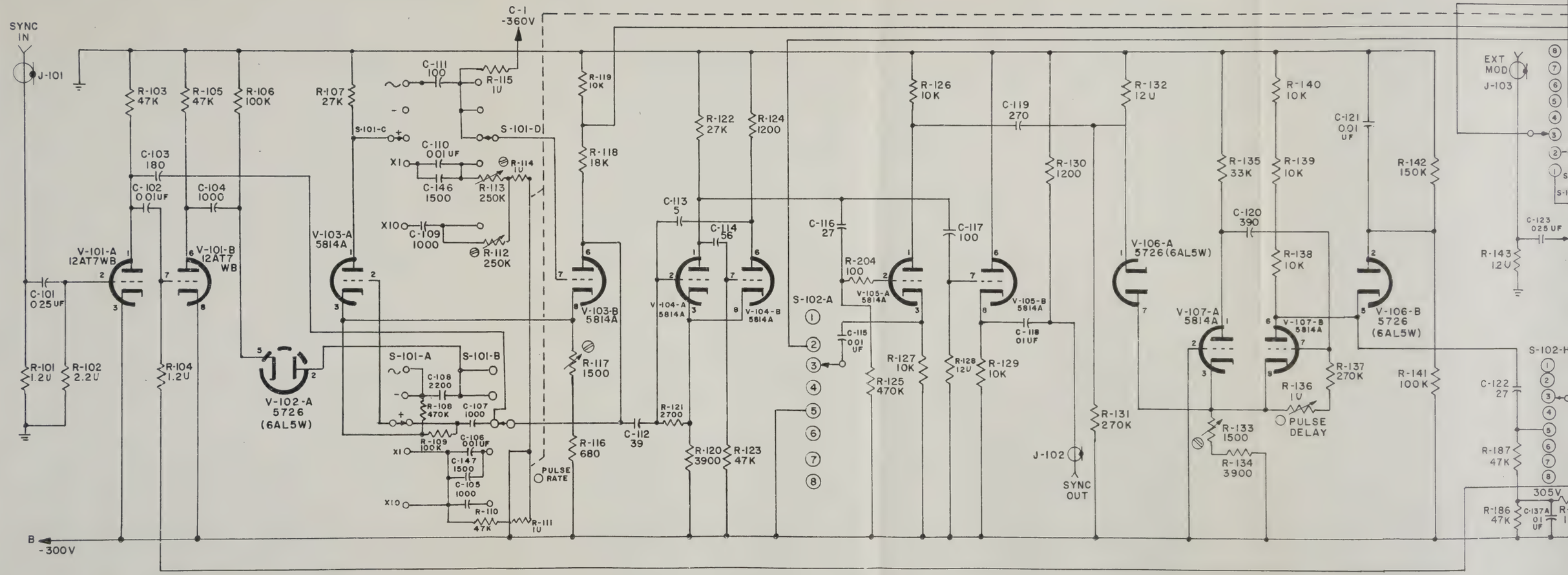


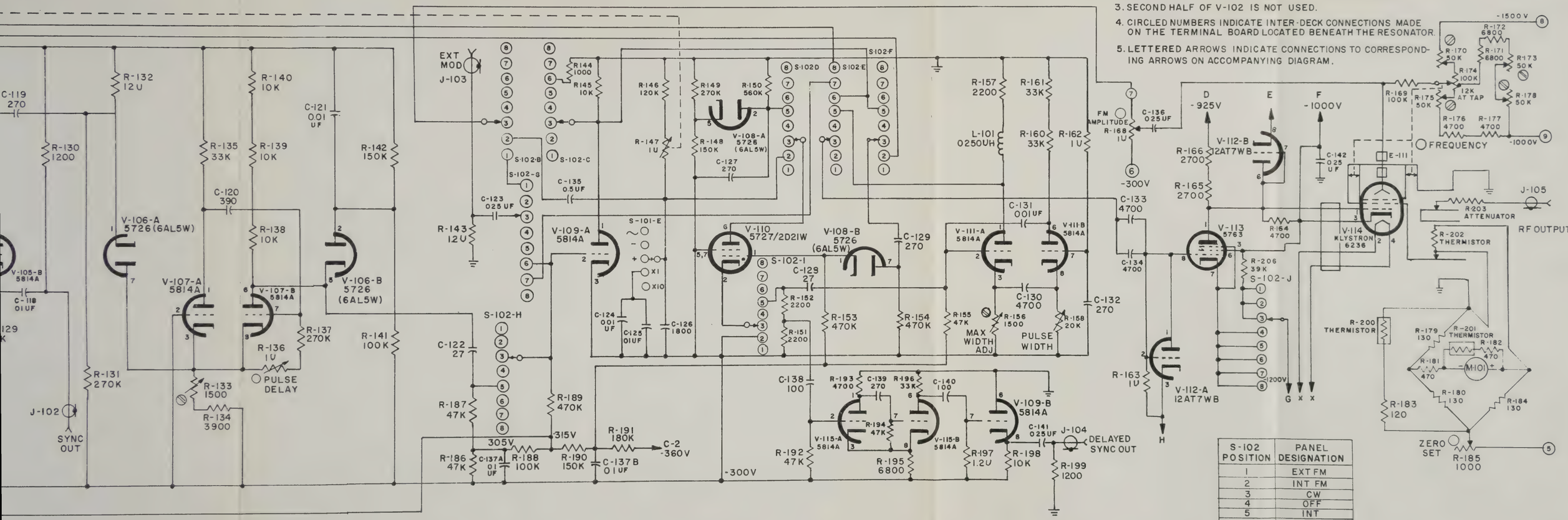
Figure 8-14. Frequency Control Assembly, Signal Generator SG-557/U Bottom View


S-102-F
S-102-D
S-102-E
R-146 120K
R-149 270K
R-150 560K
R-147 1U
R-148 150K
V-108-A 5726 (6AL5W)
C-127 270
S-101-E
X1
X10
V-110 5727/2D21W
V-108-B 5726 (6AL5W)
C-129 270
S-102-1
C-128 27
R-152 2200
R-151 2200
R-153 470K
R-154 470K
C-124 001 UF
C-125 01UF
C-126 1800
C-138 100
R-193 4700
C-139 270
R-196 33K
R-194 47K
V-115-A 5814A
R-191 180K
C-2 -360V
C-137B 01UF
R-192 47K
R-195 6800
-300V


SYNC IN
J-101
C-1 -360V
R-103 47K
R-105 47K
R-106 100K
R-107 27K
C-111 100
R-115 1U
S-101-C
S-101-D
C-110 001 UF
X1
X10
C-146 1500
R-113 250K
R-114 1U
C-109 1000
R-112 250K
C-103 180
C-102 001UF
C-104 1000
V-101-A 12AT7WB
V-101-B 12AT7 WB
V-103-A 5814A
C-101 025 UF
R-101 1.2U
R-102 2.2U
R-104 1.2U
V-102-A 5726 (6AL5W)
S-101-A
S-101-B
C-108 2200
R-108 470K
C-107 1000
R-109 100K
C-106 001UF
C-147 1500
C-105 1000
R-110 47K
R-111 1U
PULSE RATE
R-119 10K
R-118 18K
R-117 1500
V-103-B 5814A
R-116 680
C-112 39
R-121 2700
R-122 27K
R-124 1200
C-113 5
C-114 56
V-104-A 5814A
V-104-B 5814A
R-120 3900
R-123 47K
C-116 27
R-204 100
V-105-A 5814A
S-102-A
C-115 001 UF
R-125 470K
R-126 10K
R-127 10K
C-117 100
V-105-B 5814A
C-118 01UF
R-128 12U
R-129 10K
C-119 270
R-130 1200
R-131 270K
J-102
SYNC OUT
R-132 12U
V-106-A 5726(6AL5W)
V-107-A 5814A
R-133 1500
R-134 3900
R-135 33K
R-140 10K
R-139 10K
C-120 390
R-138 10K
V-107-B 5814A
R-136 1U
PULSE DELAY
R-137 270K
C-121 001 UF
R-142 150K
V-106-B 5726 (6AL5W)
R-141 100K
EXT MOD
J-103
C-123 025 UF
R-143 12U
S-102-H
C-122 27
R-187 47K
305V
R-186 47K
C-137A 01 UF
B -300V

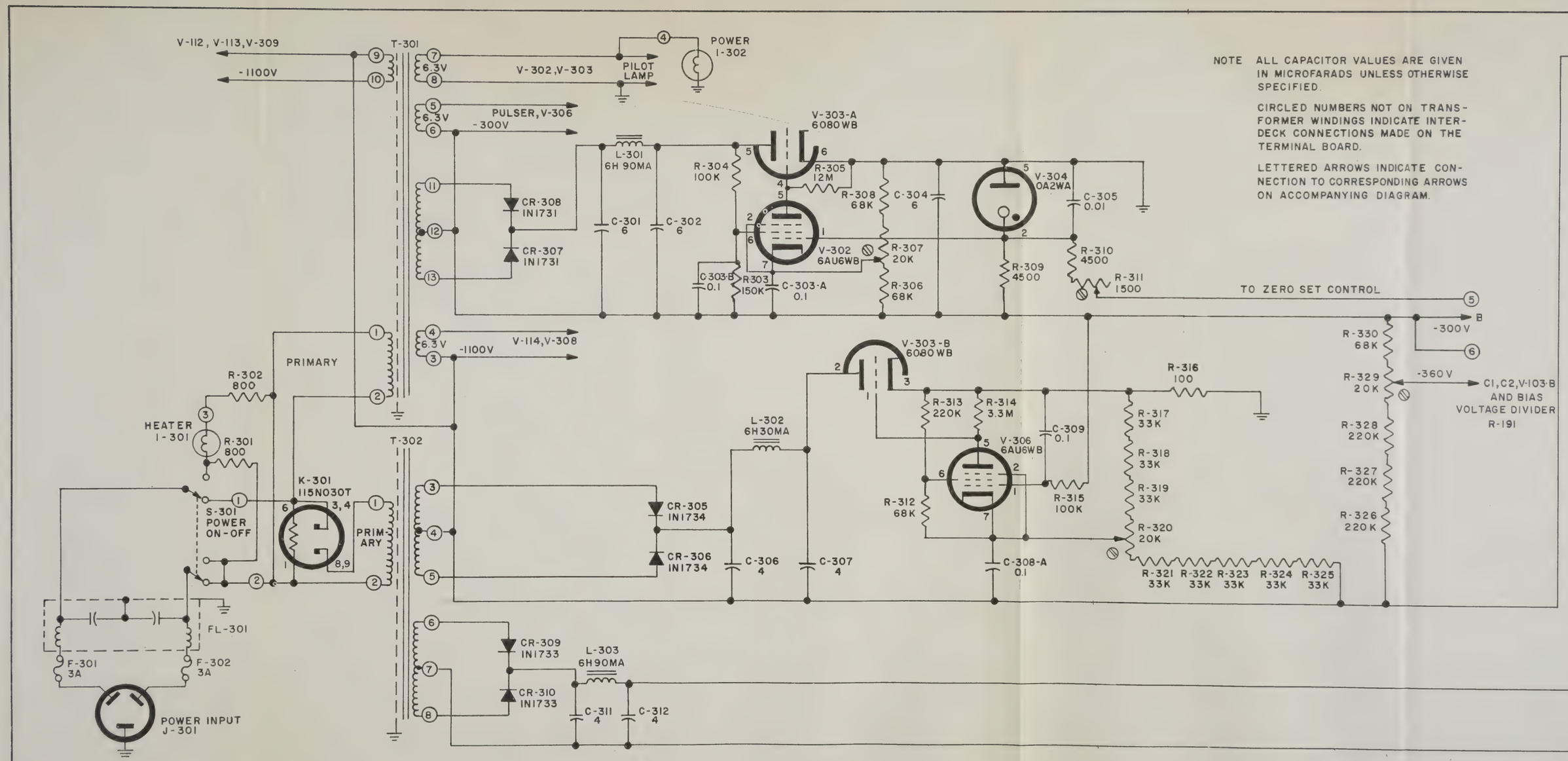
NOTES:

1. VALUES OF CAPACITORS ARE GIVEN IN MICROMICROFARADS UNLESS OTHERWISE SPECIFIED.
2. ⊘ INTERNAL ADJUSTMENT ○ FRONT PANEL CONTROL
3. SECOND HALF OF V-102 IS NOT USED.
4. CIRCLED NUMBERS INDICATE INTER-DECK CONNECTIONS MADE ON THE TERMINAL BOARD LOCATED BENEATH THE RESONATOR.
5. LETTERED ARROWS INDICATE CONNECTIONS TO CORRESPONDING ARROWS ON ACCOMPANYING DIAGRAM.



S-102 POSITION	PANEL DESIGNATION
1	EXT FM
2	INT FM
3	CW
4	OFF
5	INT
6	EXT +
7	EXT -
8	SQ WAVE

Figure 8-13. Schematic Diagram of Pulser and RF Oscillator Sections of SG-557/U



NOTE ALL CAPACITOR VALUES ARE GIVEN IN MICROFARADS UNLESS OTHERWISE SPECIFIED.

CIRCLED NUMBERS NOT ON TRANSFORMER WINDINGS INDICATE INTER-DECK CONNECTIONS MADE ON THE TERMINAL BOARD.

LETTERED ARROWS INDICATE CONNECTION TO CORRESPONDING ARROWS ON ACCOMPANYING DIAGRAM.

NOTE ALL CAPACITOR VALUES ARE GIVEN IN MICROFARADS UNLESS OTHERWISE SPECIFIED.

CIRCLED NUMBERS NOT ON TRANSFORMER WINDINGS INDICATE INTER-DECK CONNECTIONS MADE ON THE TERMINAL BOARD.

LETTERED ARROWS INDICATE CONNECTION TO CORRESPONDING ARROWS ON ACCOMPANYING DIAGRAM.

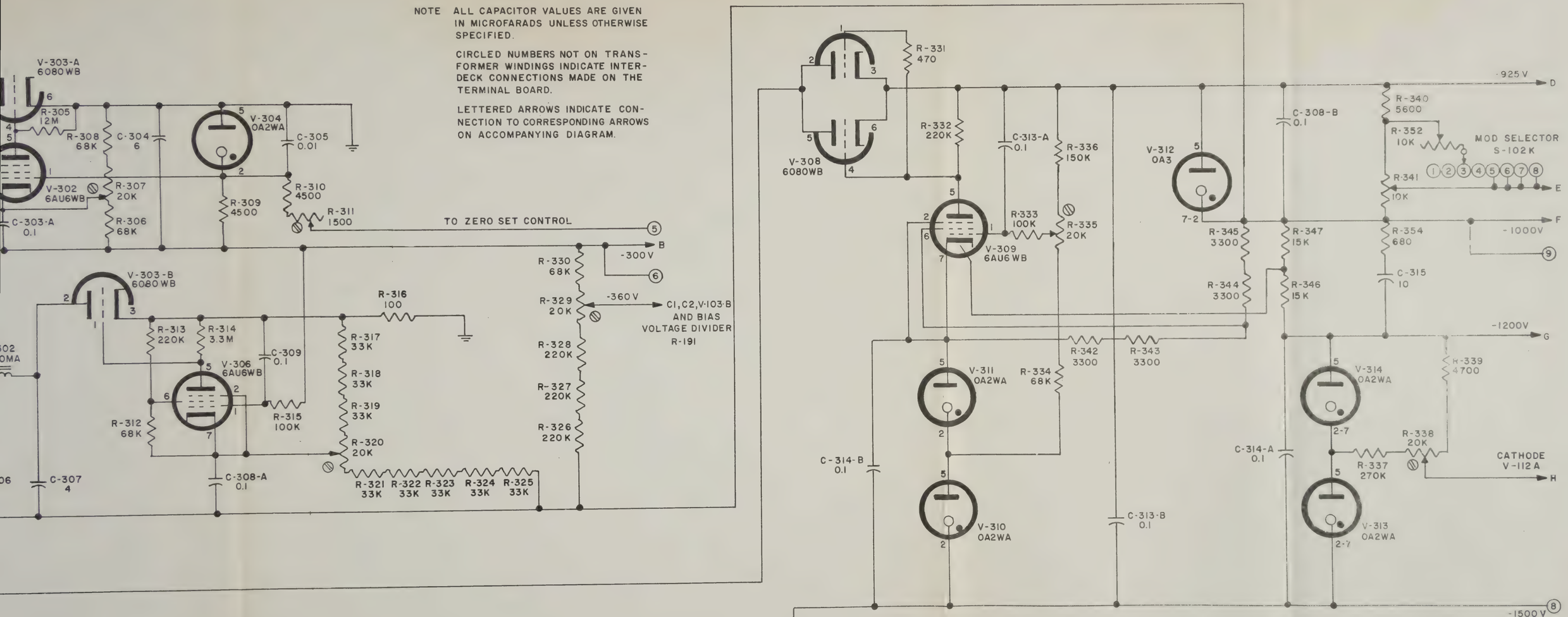


Figure 8-15. Schematic Diagram of Power Supply Section of SG-557/U

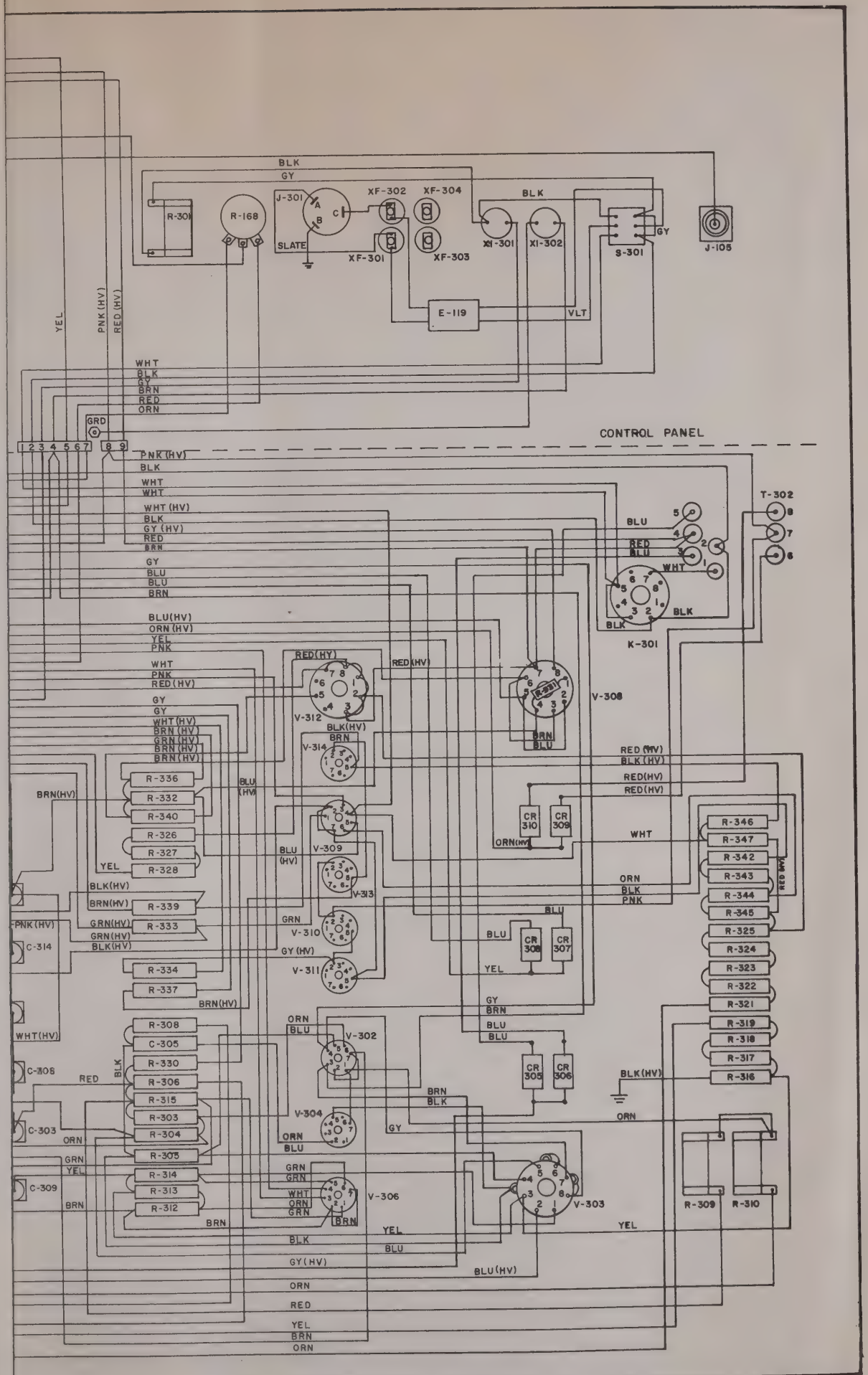


Figure 8-14. Practical Wiring Diagram Signal Generator SG-557/U

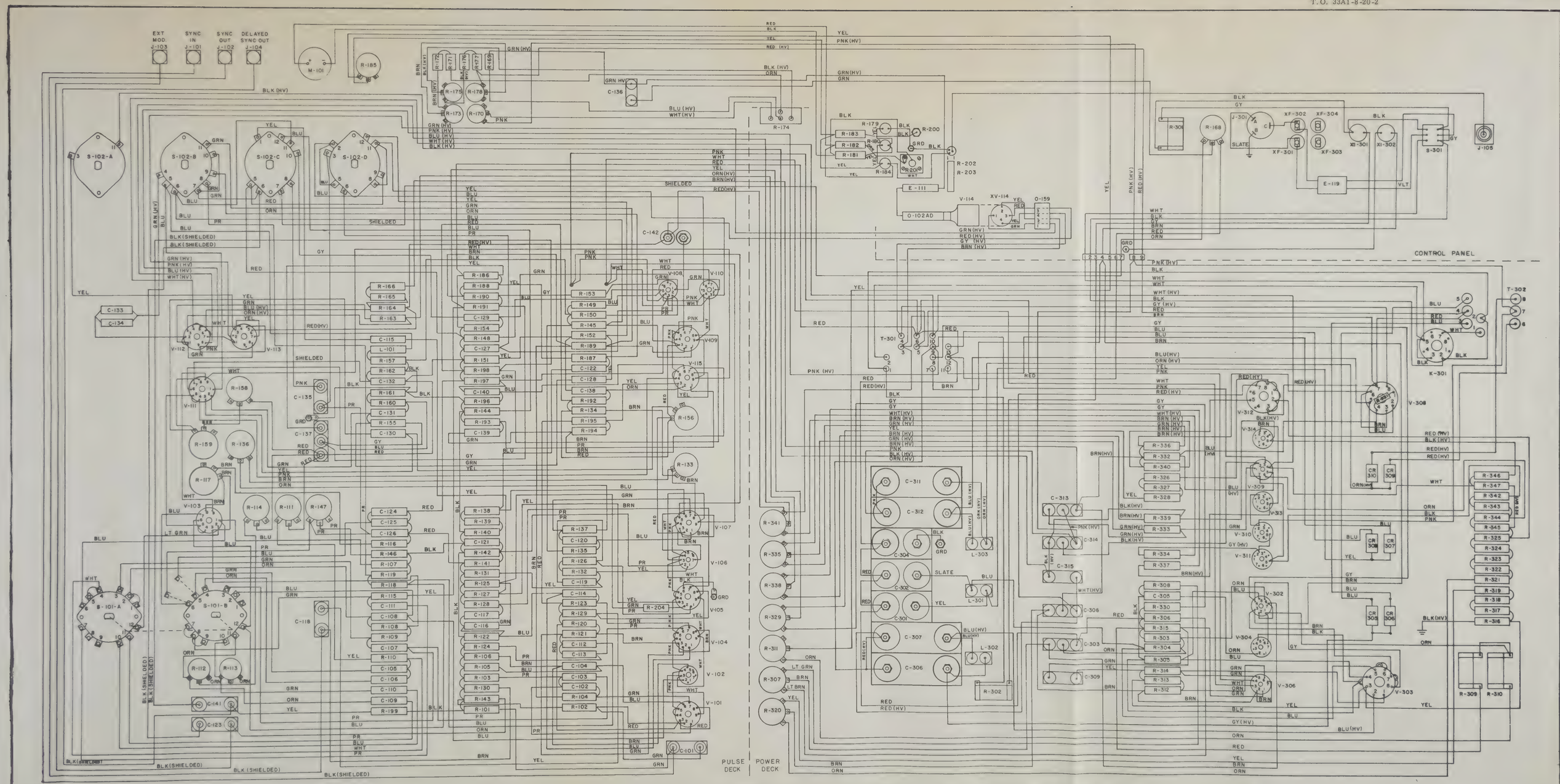


Figure 8-14. Practical Wiring Diagram Signal Generator SG-557/U

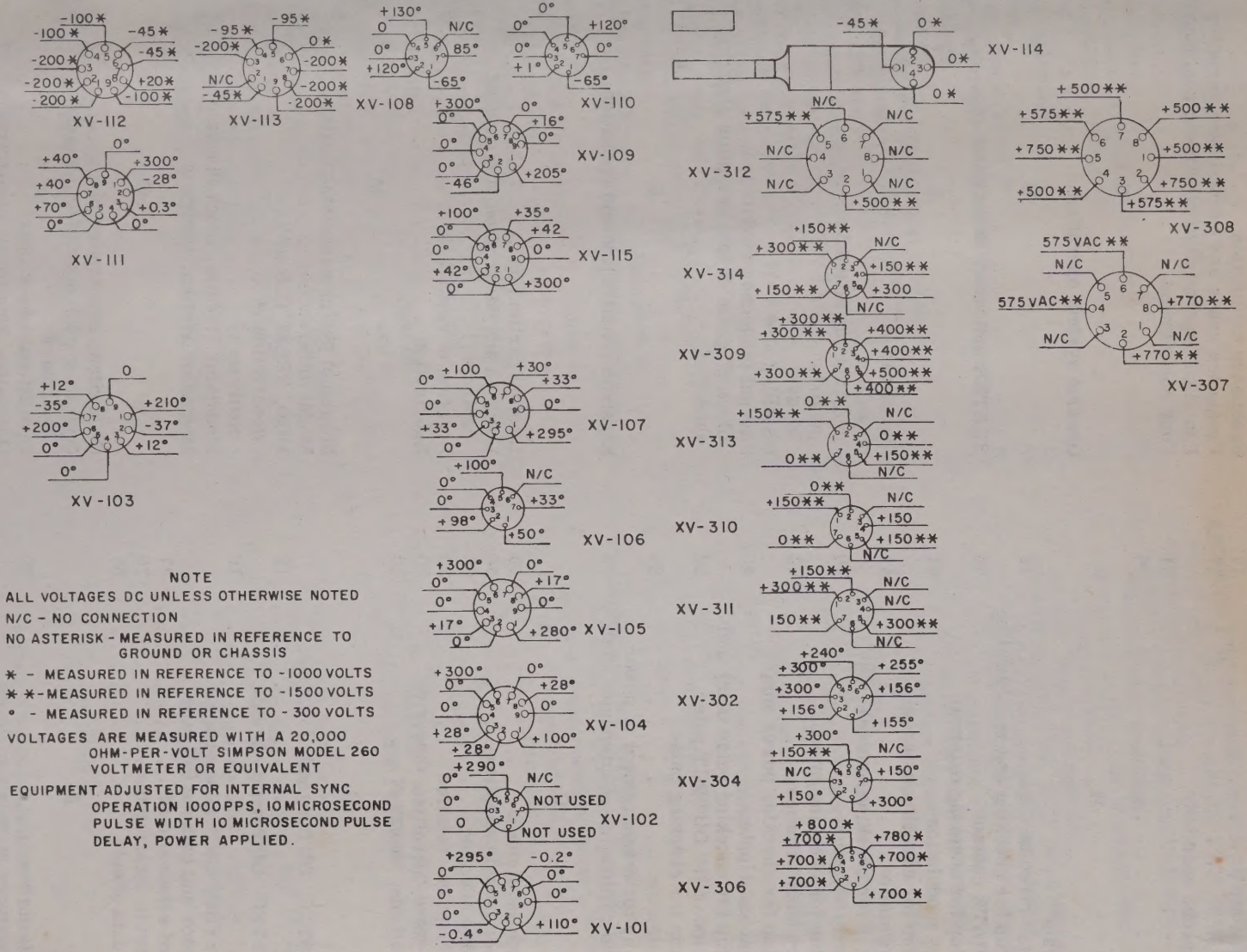


Figure 8-15. Tube Socket Voltage Measurements, Signal Generator SG-557/U

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operation of 17, 18
Attenuator probe assembly
removing 51
replacing 54

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*U.S. GOVERNMENT PRINTING OFFICE: 1968-303-058/5440